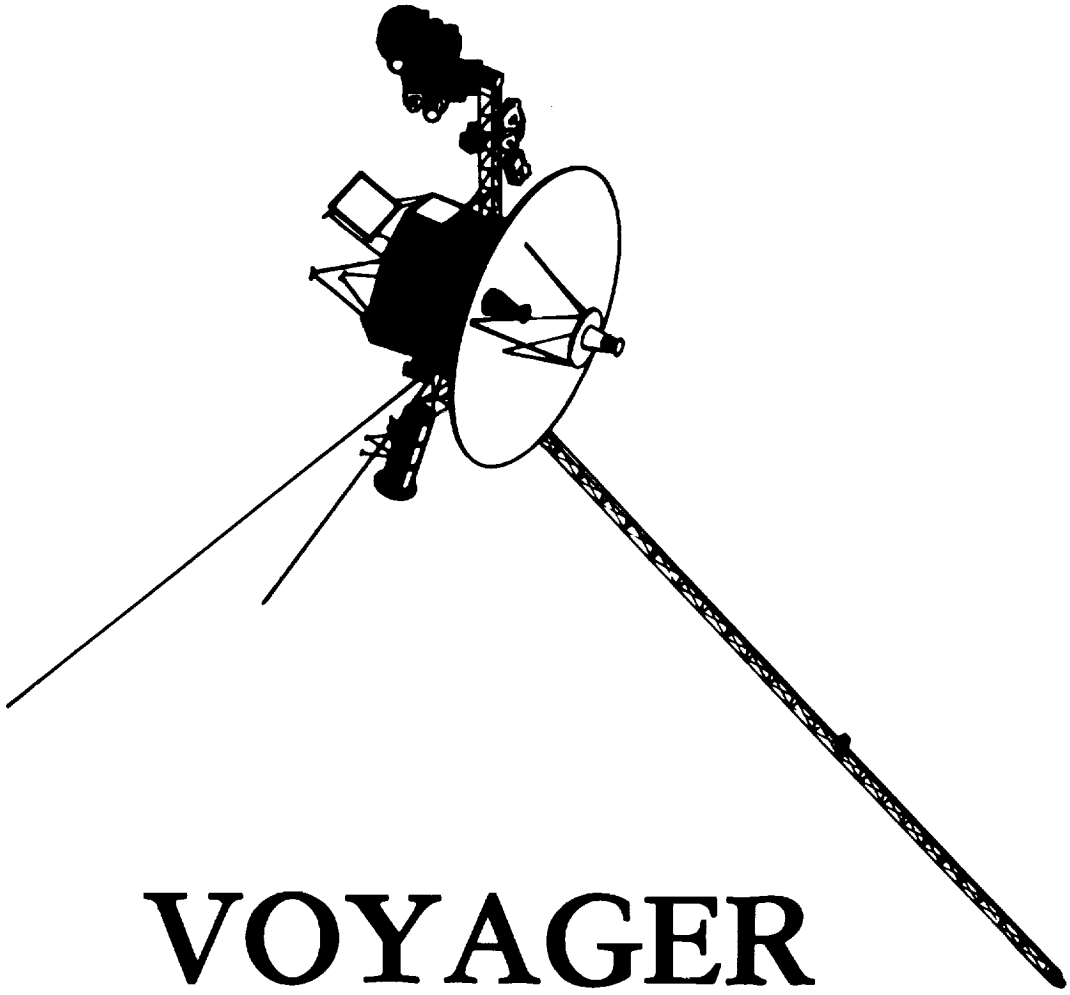
NASA-CR-197879



VOYAGER
TO JUPITER

(NASA-CR-197879) VOYAGER TO JUPITER, VOLUME 1 (JPL) 117 p

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NASA
National Aeronautics and Space Administration

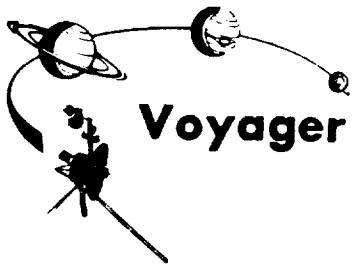
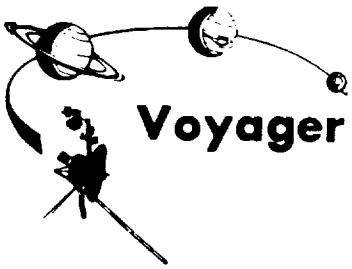


TABLE OF CONTENTS



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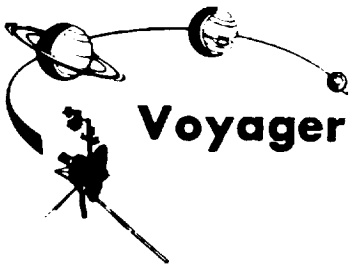

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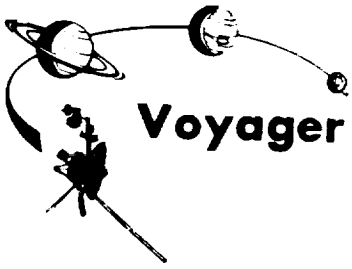

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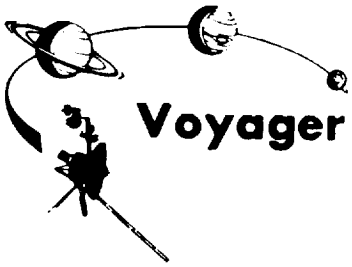
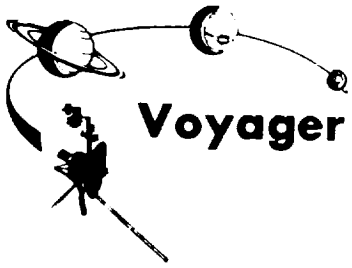


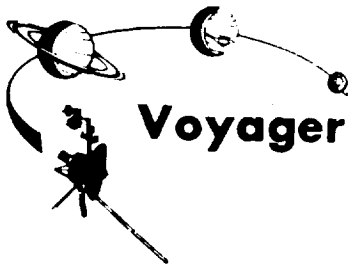
HQ # 78-HC-578
JPL # P-20829 C

Revealing more detail than the very best groundbased telescopic photographs, this Voyager 1 image of Jupiter taken December 10 from 83 million kilometers (52 million miles) shows the Great Red Spot (lower right) surrounded by a colorful and turbulent atmosphere. The entire visible surface of Jupiter is made up of multiple layers of clouds, composed primarily of ammonia ice crystals colored by small amounts of materials of unknown composition. Near the center is a bright convective cloud and an associated plume which has been swept westward (to the left) by local currents in the planet's equatorial wind system. This same atmospheric feature was seen prominently in the Pioneer 10 and 11 spacecraft pictures of Jupiter taken four and five years ago this month. Below and to the left of the Great Red Spot is a white oval cloud, one of three which formed nearly 40 years ago in the south temperate region. Largest of all of the planets, Jupiter's volume could contain more than 1200 Earths. Voyager 1 will fly past Jupiter on March 5, 1979, studying the planet and five of its 13 moons, and continue on to Saturn. An identical spacecraft, Voyager 2, arrives at Jupiter on July 9, 1979, and will proceed to Saturn and possibly Uranus. Both were launched in 1977. Among 11 science instruments, each spacecraft is equipped with two slow-scan TV cameras. This picture was taken with a camera equipped with a 1500 millimeter focal-length telescope. The color image was recreated from three TV frames, each taken through a different filter–green, orange, and blue.



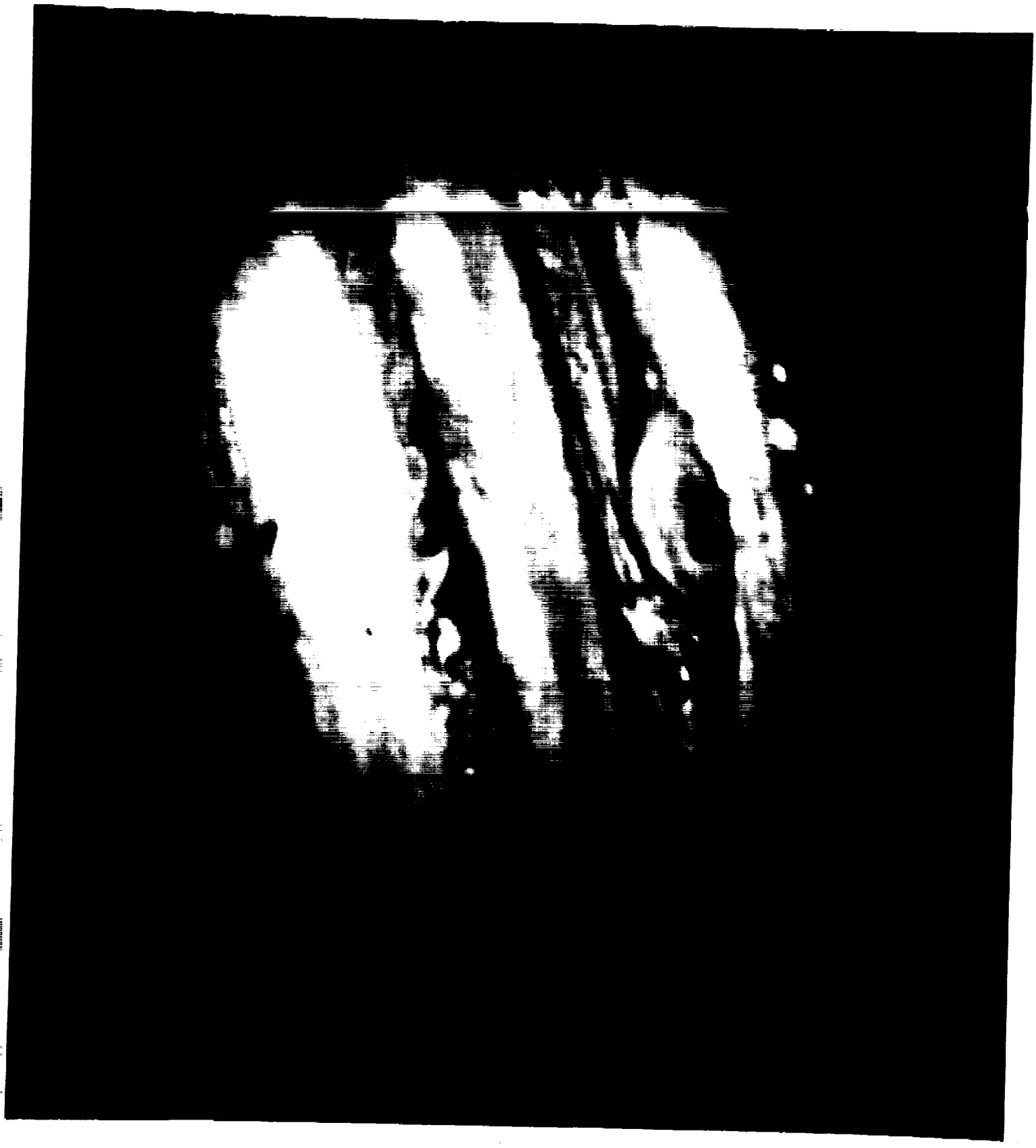
HQ # 79-HC-6
79-H-4

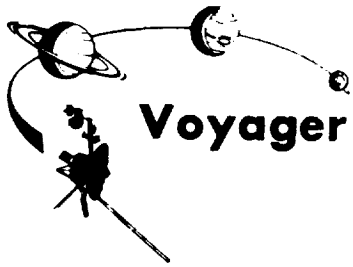
NASA's Voyager 1 took this picture of the planet Jupiter on Saturday, January 6, the first in its three-month-long, close-up investigation of the largest planet. The spacecraft, flying toward a March 5 closest approach, was 57.6 million kilometers (35.8 million miles) from Earth when the picture was taken. As the Voyager cameras begin their meteorological surveillance of Jupiter, they reveal a dynamic atmosphere with more convective structure than had previously been thought. While the smallest atmospheric features seen in this picture are still as large as 1,000 kilometers (600 miles) across, Voyager will be able to detect individual storm systems as small as five kilometers (three miles) at closest approach. The Great Red Spot can be seen near the limb at the far right. Most of the other features are too small to be seen in terrestrial telescopes. This picture was transmitted to the Jet Propulsion Laboratory through the Deep Space Network's tracking station at Madrid, Spain. The Voyager Project is managed for NASA by Caltech's Jet Propulsion Laboratory.



HQ # 79-H-9
79-HC-11

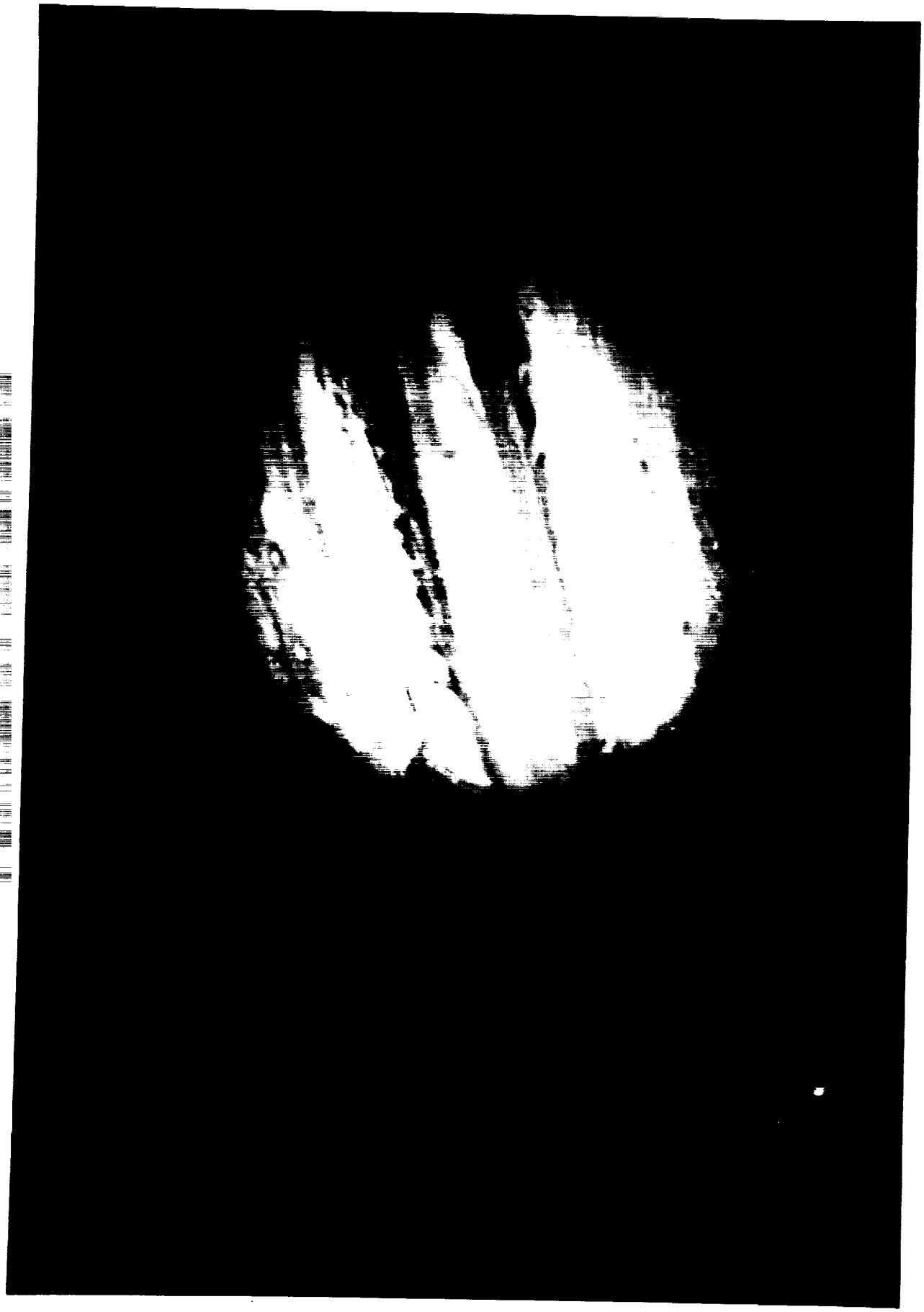
This recent photo of Jupiter taken by the television cameras aboard NASA's Voyager 1 is dominated by the Great Red Spot (top of photo is at left). Although the spacecraft is still 54 million kilometers (34 million miles) from a March 5 closest approach, Voyager's cameras already reveal details within the spot that aren't visible from Earth. An atmospheric system larger than Earth and more than 300 years old, the Great Red Spot remains a mystery and a challenge to Voyager's instruments. Swirling, storm-like features possibly associated with wind shear can be seen both to the left of and above the Red Spot. Analysis of motions of the features will lead to a better understanding of weather in Jupiter's atmosphere. This color picture, taken January 9, 1979, through three filters, was reassembled at Jet Propulsion Laboratory's Image Processing Lab. JPL manages the Voyager project for NASA.

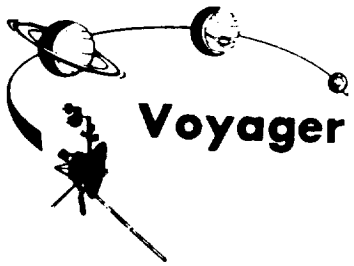




HQ # 79-HC-26
79-H-23

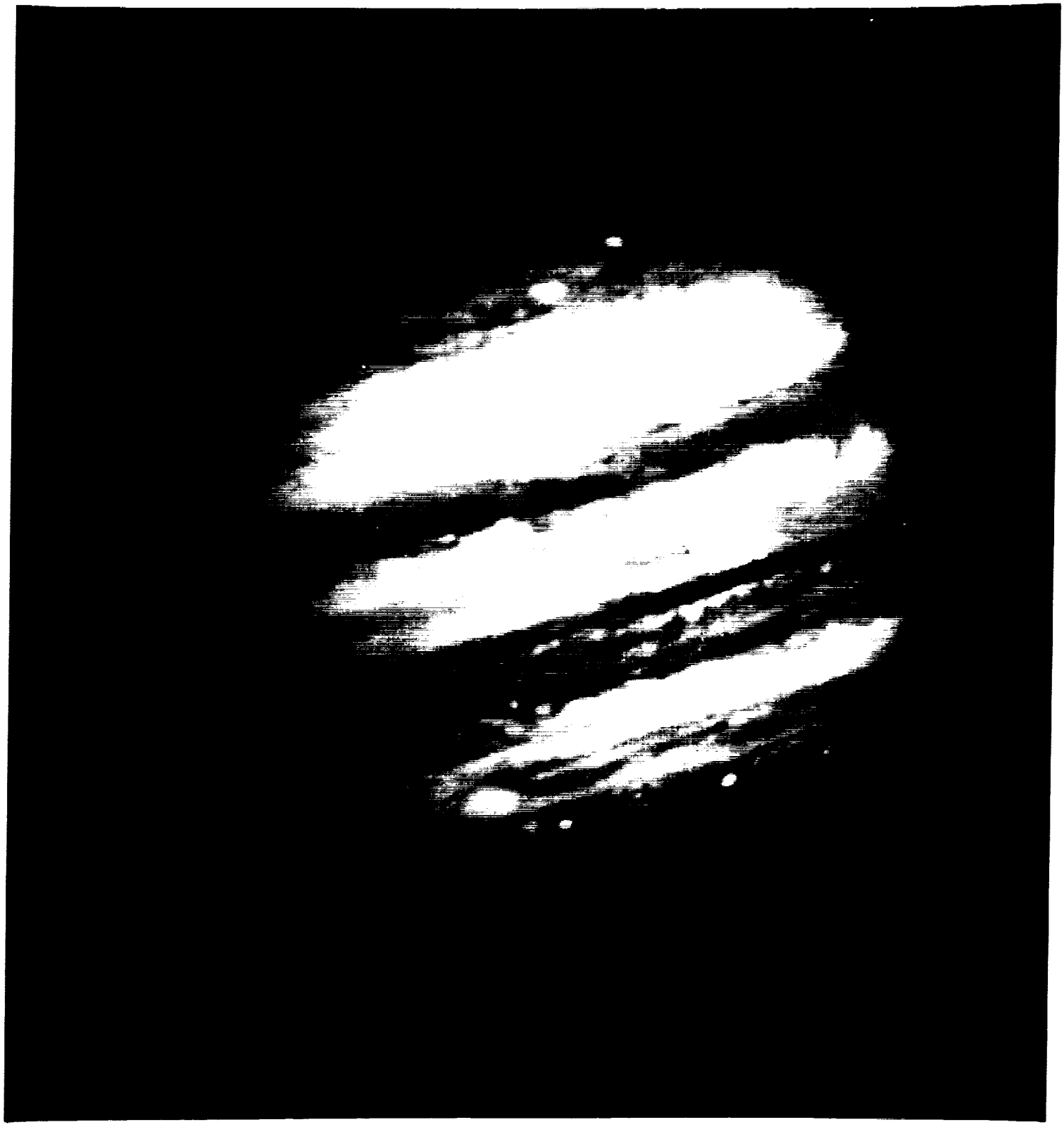
Voyager 1's cameras captured two of Jupiter's moons, Ganymede (right center) and Europa (top right) in this picture taken the morning of January 17, 1979, from a distance of 47 million kilometers (29 million miles). Top of photo is at right. Despite the small images of the moons, this photo and others are beginning to show details on the satellites not seen before in photos from Earth. Europa, an unusually bright satellite a little smaller than Earth's Moon, is revealed to have a dark equatorial band. Although scientists believe Europa is a rocky satellite, its surface appears to be covered with a layer of ice or frost of undetermined thickness. Ganymede is larger than the planet Mercury. This photo shows only the darker side of the big satellite. The hidden half seen in other photos of Ganymede is marked by a large bright region. Ganymede is believed to be composed of a mixture of rock and water ice with a surface of ice or frost with a scattering of darker soil. Scientists at Jet Propulsion Laboratory have been observing rapid changes in Jupiter's atmosphere—some occurring within 20 hours (two Jovian days). An example is changes in the long series of wave-like patterns trailing Jupiter's Great Red Spot. The bright zone stretching across the northern hemisphere may be clouds of frozen ammonia similar to cirrus clouds of water ice in Earth's atmosphere. Voyager 1 will fly by Jupiter on March 5 and continue on to a 1980 encounter with Saturn. JPL manages and controls the Voyager project for NASA's Office of Space Science.

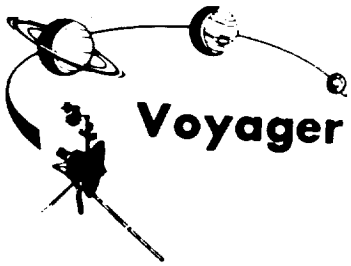




HQ # 79-H-33
79-HC-29

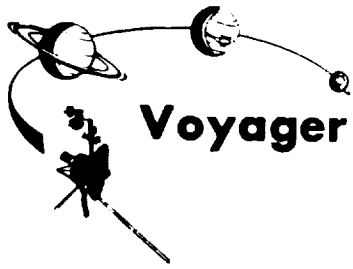
Jupiter's satellite Io poses before the giant planet in this photo returned January 7, 1979, from a distance of 47 million kilometers (29 million miles). The satellite's shadow can be seen falling on the face of Jupiter at left. Io is traveling from left to right in its one-and-three-quarter-day orbit around Jupiter. Even from this great distance the image of Io shows dark poles and a bright equatorial region. Voyager 1 will make its closest approach to Jupiter–280,000 kilometers (174,000 miles)–on March 5. It will then continue to Saturn in November 1980. Meanwhile Voyager 2, a sister spacecraft, will fly past Jupiter July 9, 1979, and reach Saturn in August 1981. This color photo was assembled at Jet Propulsion Laboratory's Image Processing Lab from three black-and-white images taken through filters.





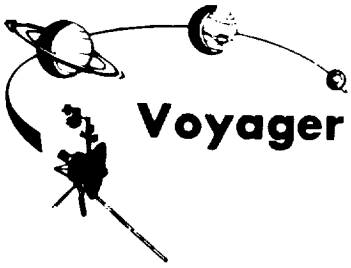
HQ # 79-H-34
79-HC-30

Voyager 1 took this photo of the planet Jupiter on January 24, while still more than 40 million kilometers (25 million miles) away. As the spacecraft draws closer to the planet (about 1 million kilometers, or 610,000 miles, a day) more details are emerging in the turbulent clouds. The Great Red Spot shows prominently below center, surrounded by what scientists call a remarkably complex region of the great planet's atmosphere. An elongated yellow cloud within the Great Red Spot is swirling around the spot's interior boundary in a counterclockwise direction with a period of a little less than six days, confirming the whirlpool-like circulation that astronomers have suspected from ground-based photographs. Ganymede, Jupiter's largest satellite, can be seen to the lower left of the planet. Ganymede is a planet-sized body larger than Mercury. This color photo was assembled at Jet Propulsion Laboratory's Image Processing Lab from three black-and-white images taken through filters. The Voyagers are managed for NASA's Office of Space Science by Jet Propulsion Laboratory.



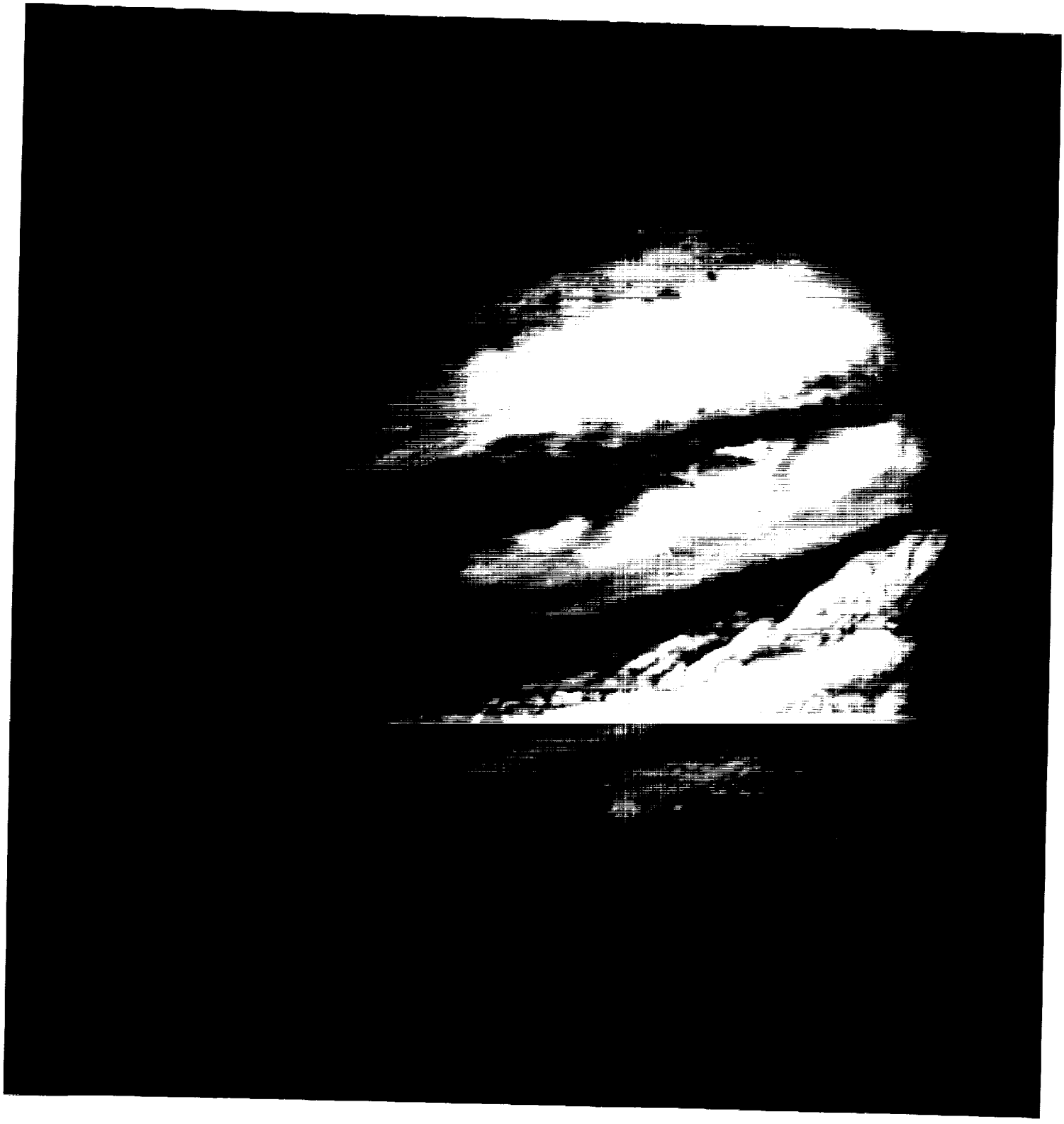
HQ # 79-HC-40
79-H-49

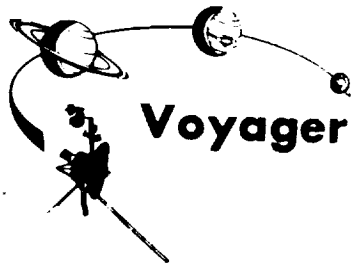
This picture of Jupiter was taken January 29, 1979, by Voyager 1 when it was 35.6 million kilometers (22 million miles) from the planet. The Great Red Spot covers a portion of the planet about three times the size of Earth. With this and other pictures, scientists are able to detect counterclockwise motion within the spot. In the 25 days since the Voyager 1 encounter began, the planet has grown steadily in the spacecraft's camera eyes, and scientists have seen features change within one or two days. Generally, dark features on Jupiter are warm; light features are cold. The exception is the Great Red Spot, the coldest place on the planet. The Great Red Spot is believed to soar about 25 kilometers (15 miles) above the surrounding clouds. Voyager 1 will pass within 280,000 kilometers (174,000 miles) of Jupiter's clouds on March 5, 1979. This picture was taken through the camera's blue filter.



HQ # 79-HC-41
79-H-50

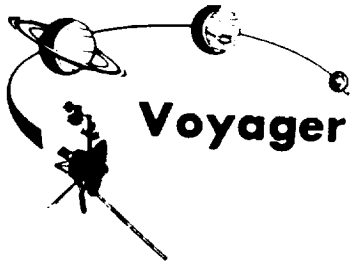
This photo of Jupiter taken January 27, 1979, shows a rapidly changing planet dominated by its distinctive light zones and dark belts. The Great Red Spot can just be seen along the limb at extreme right. The Voyager 1 spacecraft took this image from 37.5 million kilometers (23.3 million miles) away. The dark brown spot in the northern hemisphere is one of several similar features detected by Voyager's cameras. They vary in size. A thin brown band in the light zone north of the spot is the location of a high-speed jet stream similar to Earth's jet stream. Voyager 1 will take more than 15,000 pictures of Jupiter and its major satellites by the time it has completed its three-month encounter with the giant planet. This picture was taken through the camera's blue filter.





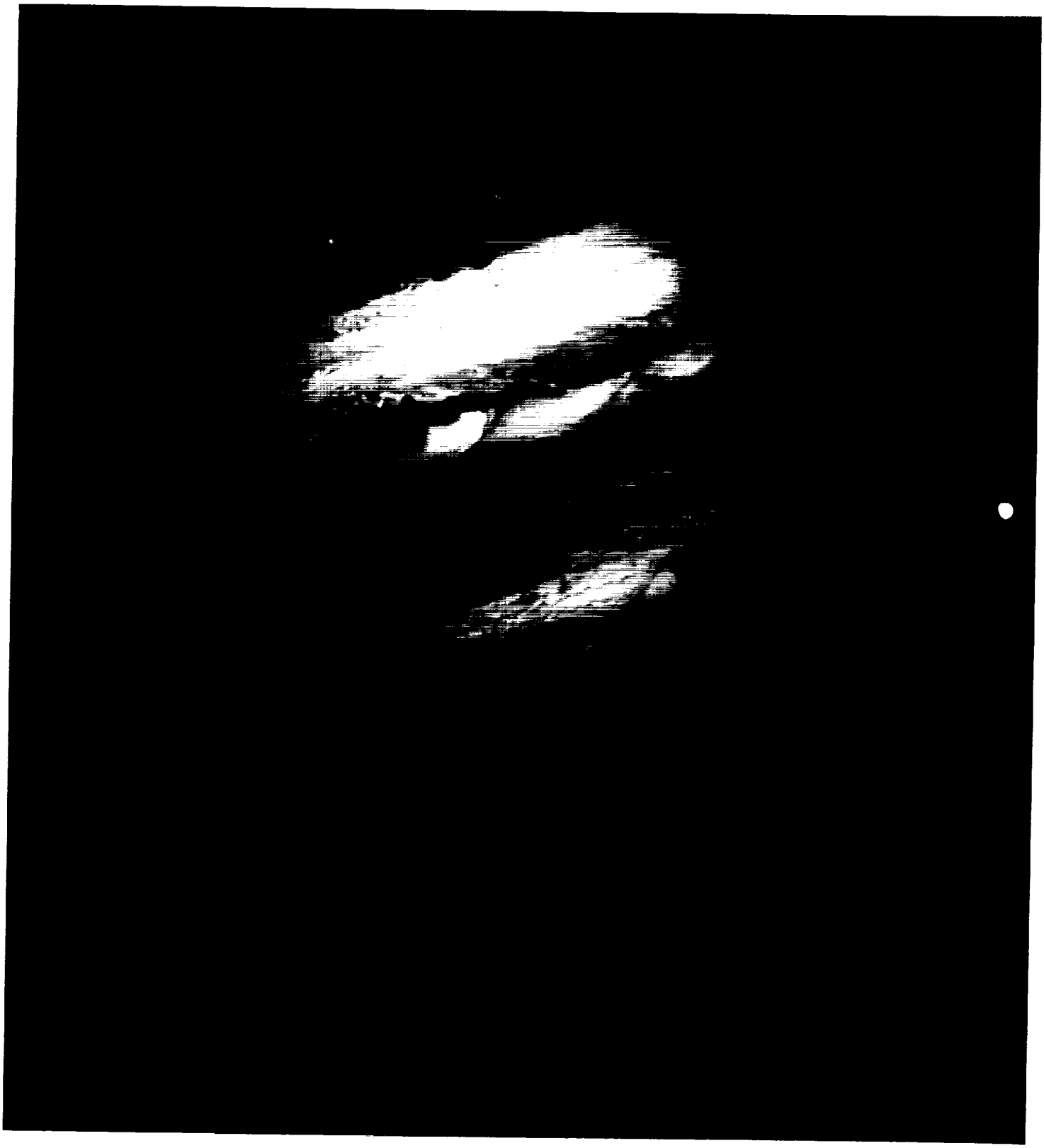
HQ # 79-HC-63
79-H-78

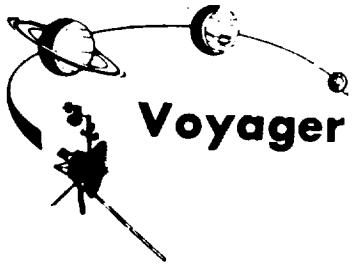
Voyager 1 took this photo of Jupiter February 1, 1979, at a range of 32.7 million kilometers (20 million miles). Voyager scientists can now see that different colors in clouds around the Great Red Spot imply that the clouds swirl around the spot at varying altitudes. They also observe apparently regular spacing between the small white spots in the southern hemisphere and similar positioning of dark spots in the northern hemisphere. A major activity will be to understand the form and structure of the spots and how they may relate to interactions between the atmospheric composition and its motions. When scientists compare this image with the 6,000 others already taken, they see many changes both large and small. The bright cloud in the equatorial region north of the Great Red Spot, for example, appears to be where bright ovals south of the Great Red Spot were seen to form about 40 years ago, and have remained much the same ever since. The Great Red Spot itself has been observed for hundreds of years, though never in the detail seen here. Objects as small as 600 kilometers (375 miles) across can be seen in this image. That resolution is the best achieved of Jupiter. This black-and-white photo was taken through a blue filter. The Voyager Project is managed for NASA's Office of Space Science by Jet Propulsion Laboratory.



HQ # 79-H-80
79-HC-65

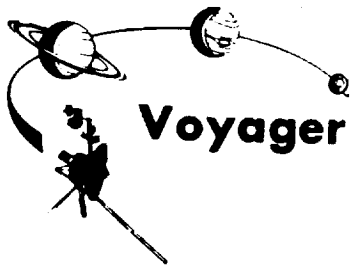
Jupiter, its Great Red Spot, and three of its four largest satellites are visible in this photo taken February 5, 1979, by Voyager 1. The spacecraft was 28.4 million kilometers (17.5 million miles) from the planet at the time. The innermost large satellite, Io, can be seen against Jupiter's disk. Io is distinguished by its bright, brown-yellow surface. To the right of Jupiter is the satellite Europa, also very bright but with fainter surface markings. The darkest satellite, Callisto (still nearly twice as bright as Earth's Moon), is barely visible at the bottom left of the picture. Callisto shows a bright patch in its northern hemisphere. All three orbit Jupiter in the equatorial plane, and appear in their present position because Voyager is above the plane. All three satellites show the same face to Jupiter always—just as Earth's Moon always shows us the same face. In this photo we see the sides of the satellites that always face away from the planet. Jupiter's colorfully banded atmosphere displays complex patterns highlighted by the Great Red Spot, a large circulating atmospheric disturbance. This photo was assembled from three black-and-white negatives by the Image Processing Lab at Jet Propulsion Laboratory. JPL manages and controls the Voyager project for NASA's Office of Space Science.





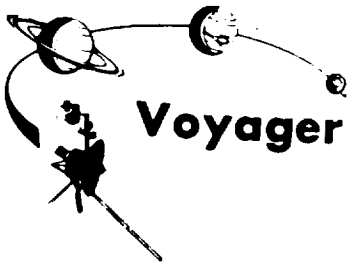
HQ # 79-H-81
79-HC-66

Voyager 1 took this photo of Jupiter and two of its satellites (Io, left, and Europa) on February 13, 1979. Io is about 350,000 kilometers (220,000 miles) above Jupiter's Great Red Spot; Europa is about 600,000 kilometers (375,000 miles) above Jupiter's clouds. Although both satellites have about the same brightness, Io's color is very different from Europa's. Io's equatorial region shows two types of material—dark orange, broken by several bright spots—producing a mottled appearance. The poles are darker and reddish. Preliminary evidence suggests color variations within and between the polar regions. Io's surface composition is unknown, but scientists believe it may be a mixture of salts and sulfur. Europa is less strongly colored, although still relatively dark at short wavelengths. Markings on Europa are less evident than on the other satellites, although this picture shows darker regions toward the trailing half of the visible disk. Jupiter is about 20 million kilometers (12.4 million miles) from the spacecraft. At this resolution (about 400 kilometers, or 250 miles) there is evidence of circular motion in Jupiter's atmosphere. While the dominant large-scale motions are west-to-east, small-scale movement includes eddy-like circulation within and between the bands. This photo was assembled from three black-and-white negatives by the Image Processing Lab at Jet Propulsion Laboratory. JPL manages and controls the Voyager project for NASA's Office of Space Science.



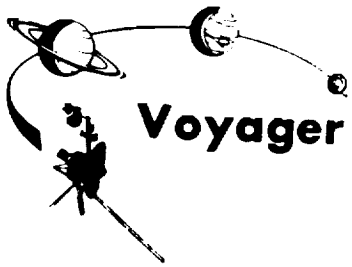
HQ # 79-H-89
79-HC-70

This dramatic view of Jupiter's Great Red Spot and its surroundings was obtained by Voyager 1 February 25, 1979, when the spacecraft was 9.2 million kilometers (5.7 million miles) from Jupiter. Cloud details as small as 160 kilometers (100 miles) across can be seen here. The colorful, wavy cloud pattern to the left of the Red Spot is a region of extraordinarily complex and variable wave motion. This black-and-white photo was taken through a violet filter.



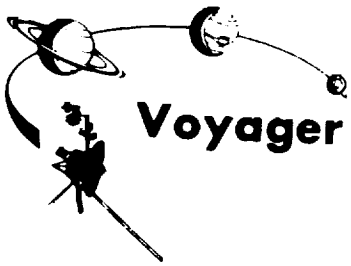
HQ # 79-HC-71
79-H-90

This view of Jupiter was obtained by Voyager 1 on February 22, 1979, from a distance of 12.2 million kilometers (7.6 million miles). It shows the Great Red Spot just emerging from the brief, five-hour Jovian night (top of photo is at left). One of three bright, oval clouds which were observed to form approximately 40 years ago can be seen immediately below the Red Spot. Most of the other features appearing in this view are too small to be seen clearly from Earth. This black-and-white photo was taken through a violet filter.



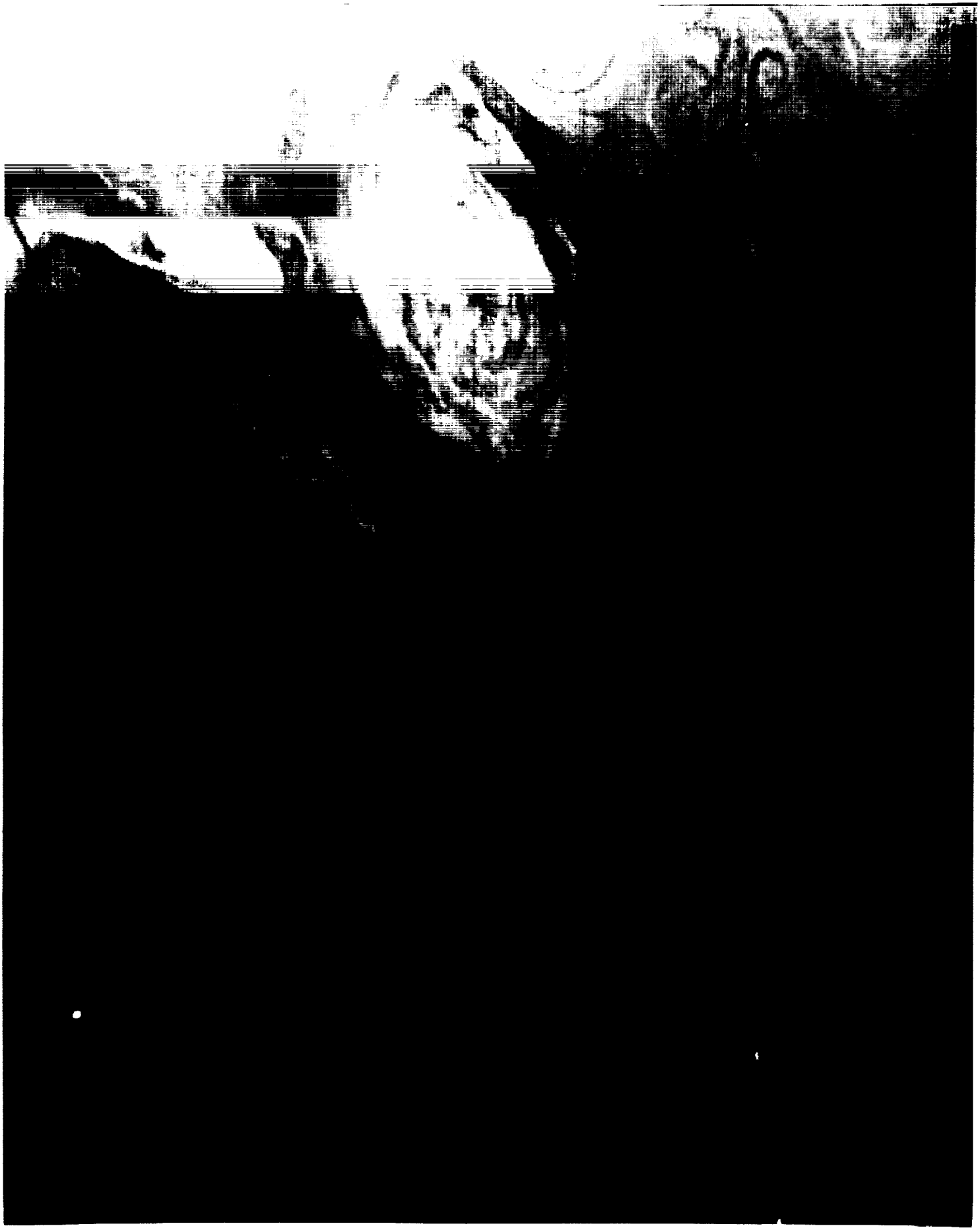
HQ # 79-H-96
79-HC-72

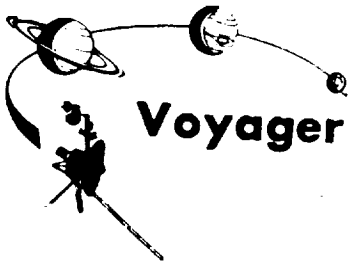
This photo of Jupiter from Voyager 1 shows scientists never-before-seen small-scale features in the planet's atmosphere, and may provide new views deep into the cloud layers boiling on the surface. The photo was taken late in the evening of February 19, from a distance of 14 million kilometers (8.8 million miles). New, small-scale features may be seen in the North Tropical Zone—the broad, bright band in the upper portion of the photo (top of photo is at left). The small, dark oval near the right edge of the North Tropical Zone may offer a glimpse deep into Jupiter's atmosphere; more study will be required to make certain. Between the regularly spaced dark ovals near the bottom of the frame are more small-scale features that are being studied for their role in the Jovian atmospheric activity. The blue-gray regions along the shear line between the Equatorial Zone and the North Equatorial Belt also appear to be windows into the deeper regions of the atmosphere. Earth-based observations tend to show that these areas are warmer than surrounding regions.



HQ # 79-H-97
79-HC-73

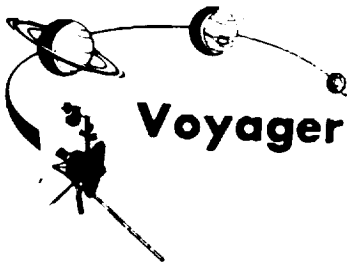
This photo of Jupiter was taken by Voyager 1 on the evening of March 1, 1979, from a distance of 4.3 million kilometers (2.7 million miles). The photo shows Jupiter's Great Red Spot (top) and one of the white ovals that can be seen in Jupiter's atmosphere from Earth (top of photo is at left). The white ovals were seen to form in 1939 and 1940, and have remained more or less constant ever since. None of the structure and detail evident in these features has ever been seen from Earth. The Great Red Spot is three times as large as Earth. Also evident in the picture is a great deal of atmospheric detail that will require further study for interpretation. The smallest details that can be seen in this picture are about 75 kilometers (45 miles) across.





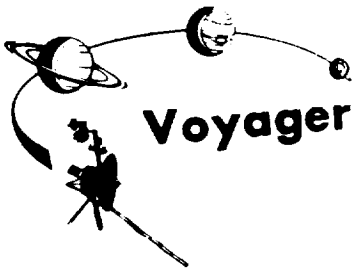
HQ # 79-H-98
79-HC-74

This photo of Jupiter was taken by Voyager 1 on March 1, 1979. The spacecraft was 5 million kilometers (3 million miles) from Jupiter at the time. The photo shows Jupiter's Great Red Spot (upper right) and the turbulent region immediately to the west (top of photo is at left). At the middle right of the frame is one of several white ovals seen on Jupiter from Earth. The structure in every feature here is far better than has ever been seen from any telescopic observations. The Great Red Spot and the white oval both reveal intricate and involved structures. The smallest details that can be seen in this photo are about 90 kilometers (55 miles) across.



HQ # 79-HC-75
79-H-99

This photo of Jupiter was taken by Voyager 1 on March 1, 1979, from a distance of 4.3 million kilometers (2.7 million miles). The view is toward the east from the Great Red Spot (top of photo is at left). The dark halo surrounding the smaller bright spot to the right of the large oval is, scientists say, almost certainly a five-micron hot spot—a region of Jupiter's atmosphere that is warmer than those around it. That could indicate that, in the dark halo, we are looking deep into Jupiter's atmosphere. The swirling streamer-like features in the photo may be associated with the bright spots, although the connection is not yet understood.



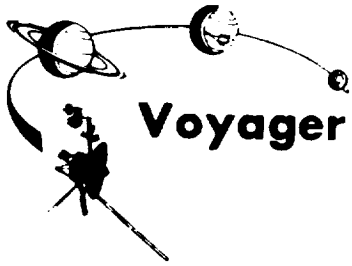
HQ # 79-HC-76
79-H-100

This photo of Jupiter was taken by Voyager 1 on March 1, 1979, from a distance of 4.3 million kilometers (2.7 million miles). The region shown is just to the southeast of the Great Red Spot (top of photo is at left). A small section of the spot can be seen at upper left. One of the 40-year-old white ovals in Jupiter's atmosphere can also be seen at middle left, as well as a wealth of other atmospheric features, including the flow lines in and around the ovals. The smallest details that can be seen in this photo are about 75 kilometers (45 miles) across.

Voyager

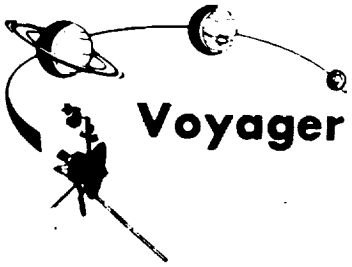
HQ # 79-HC-86

This view of the region just to the southeast of the Great Red Spot is seen in greatly exaggerated color. The colors do not represent the true hues seen in the Jovian atmosphere but have been produced by special computer processing to enhance subtle variations in both color and shading. JPL manages and controls the Voyager Project for NASA's Office of Space Science.



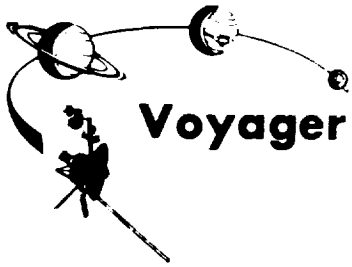
HQ # 79-HC-91

This view of the Great Red Spot is seen in greatly exaggerated color. The colors do not represent the true hues seen in the Jovian atmosphere but have been produced by special computer processing to enhance subtle variations in both color and shading.



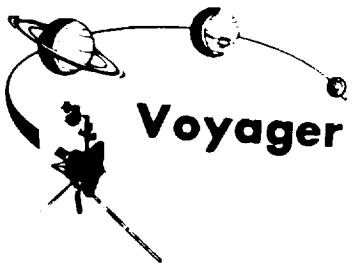
HQ # 79-HC-92

This color view of the Great Red Spot was taken by Voyager 1 on March 4, 1979, at a distance of 1,800,000 kilometers (1,100,000 miles). Differences in cloud color may indicate relative heights of the cloud layers, but the exact relationship between color and height has not yet been established. The smallest clouds seen in this picture are approximately 30 kilometers (20 miles) across.



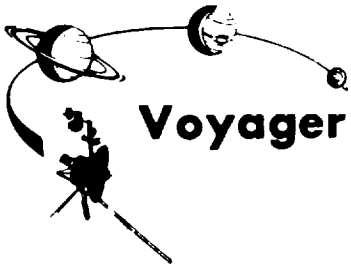
HQ # 79-HC-93

This color view of the region just to the east of the Great Red Spot was taken by Voyager 1 on March 4, 1979, at a distance of 1,800,000 kilometers (1,000,000 miles). Top of photo is at left. Differences in cloud color may indicate relative heights of the cloud layers, but the exact relationship between color and height has not yet been established. The smallest clouds seen in this picture are approximately 30 kilometers (20 miles) across.



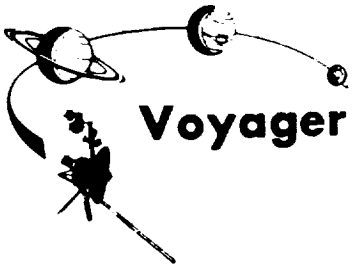
HQ # 79-HC-94

This view of the region just to the east of the Great Red Spot is seen in greatly exaggerated color. The colors do not represent the true hues in the Jovian atmosphere but have been produced by special computer processing to enhance subtle variations in both color and shading. JPL manages and controls the Voyager Project for NASA's Office of Space Science.



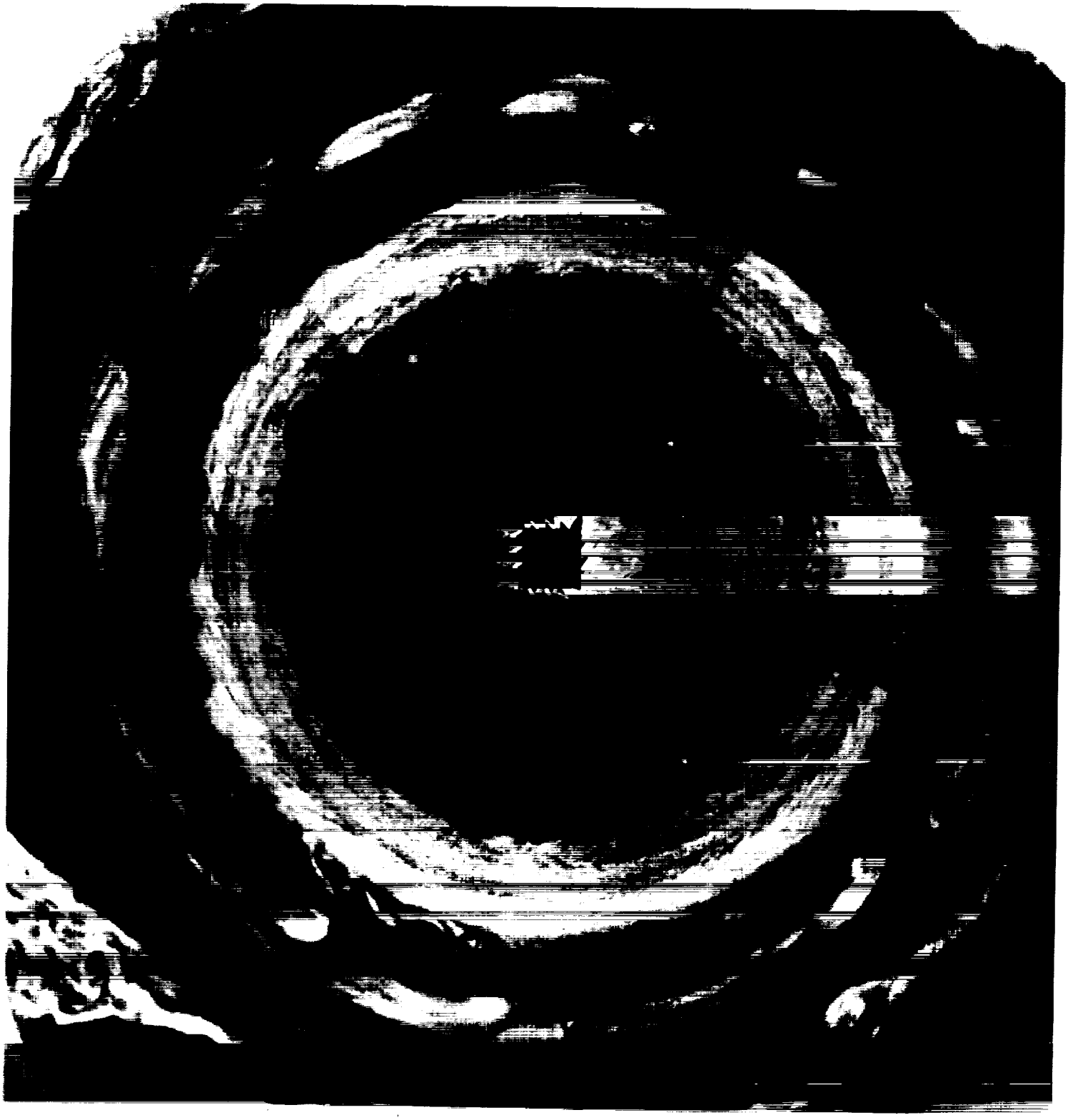
HQ # 79-H-336
79-HC-246

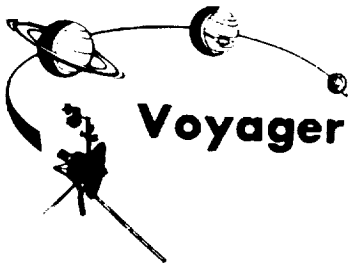
This Voyager 1 picture of the Great Red Spot (GRS) shows a white oval with its "wake" of counter-rotating vortices. North is at the top (top of photo is at right) and the distance from top to bottom is about 24,000 kilometers (15,000 miles). This enhanced color view emphasizes red and blue at the expense of green. Note the puffy features inside the GRS, and the "reverse-S" spirals inside both the GRS and the oval. The large white feature extending over the northern part of the GRS was observed to revolve about the GRS center with a period of six days.



HQ # 79-H-359
79-HC-257

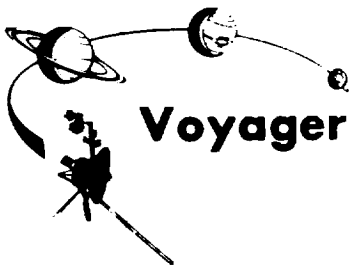
This is one of a pair of photos constructed by Jet Propulsion Laboratory's Image Processing Lab to give views of the northern and southern hemispheres of Jupiter from directly above the poles. In that way, the features at high latitudes are shown more clearly than would be possible in other projections. Sets of pictures taken by Voyager 1 at a resolution of 600 kilometers (375 miles) have been used to construct these polar stereographic projections. In this northern hemisphere image, the northward extent of the belt-zone structure is clearly shown to at least 50 degrees north latitude. Even though this visible appearance of the planet becomes less apparent at higher latitudes, discrete cloud features still seem to be zonally positioned. At the northern edge of the equatorial region the plumes are evenly spaced around the planet. Positions of the active cloud plumes, marked by bright nuclei, are not symmetrical. At about 32 degrees north, dark cloud vortices that move in westerly currents at about 30 meters per second (67 miles an hour) can be seen. The spacings of those features vary, and cloud systems have been seen to interact, one rolling over another in the region. The broad white region is divided by the North Temperate Belt's high-speed jet, seen as a thin brown line.





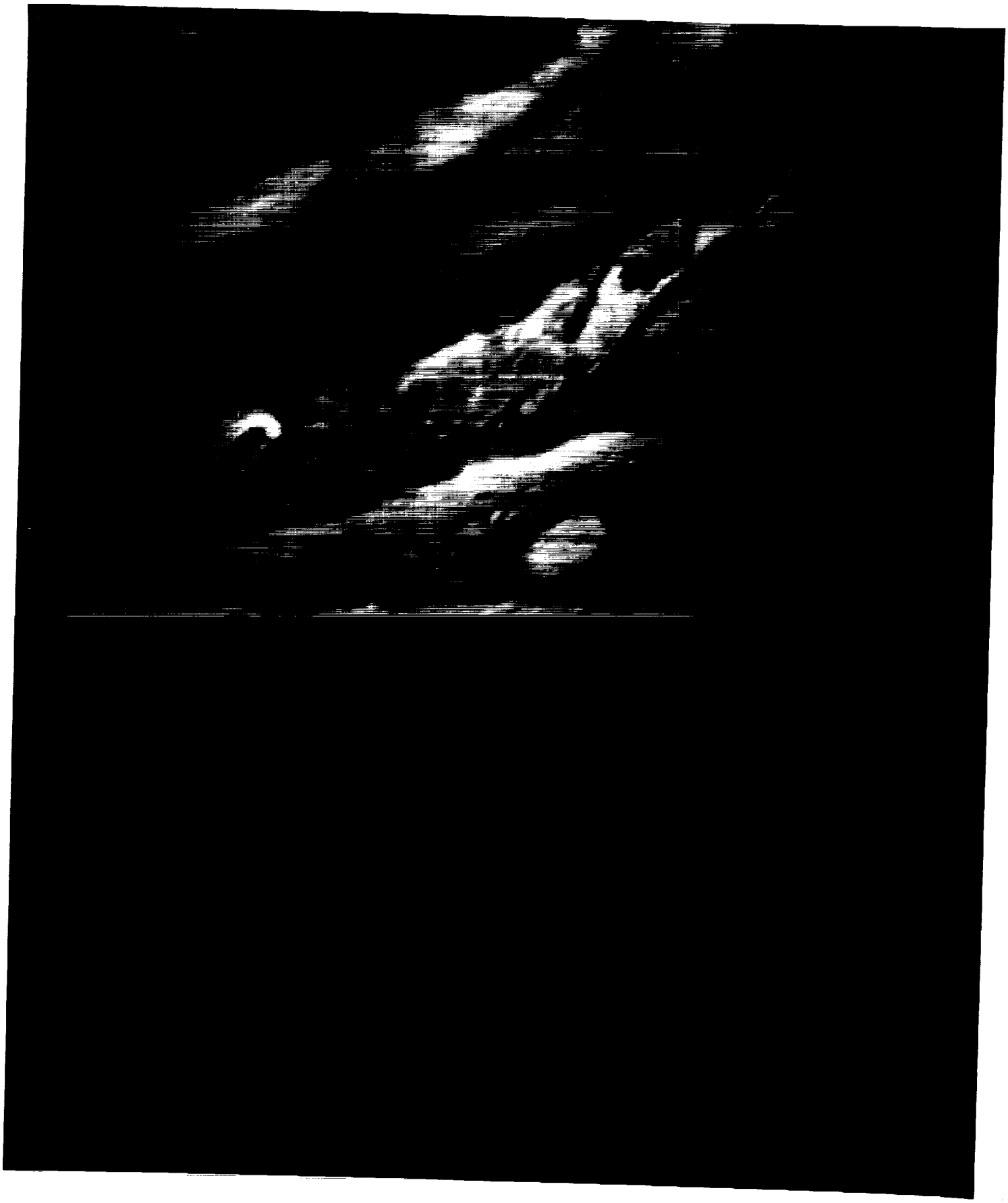
HQ # 79-H-360
79-HC-258

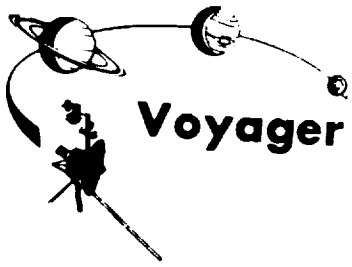
This is the second of a pair of photos constructed by Jet Propulsion Laboratory's Image Processing Lab from Voyager images to give views of the southern and northern hemispheres of Jupiter from directly above the poles. In that way, features at high latitudes are shown more clearly than would be possible in other projections. Sets of pictures taken by Voyager 1 at a resolution of 600 kilometers (375 miles) have been used to construct these polar stereographic projections. This southern hemisphere image can be compared with the northern hemisphere companion by aligning the Great Red Spot and the bright plume that occurs at the same longitude. The southern hemisphere shows three white ovals and a large region of the same zone, without any discrete features; smaller-scale spots, almost equally spaced, covering about 270 degrees of longitude; and the disturbance trailing from the Great Red Spot and extending about 180 degrees in longitude from it. Features are zonally spaced in the higher latitudes, even though the belt-zone structure disappears. (The first two features are suggestive of wave interactions.) The Voyager Project is managed by the Jet Propulsion Laboratory, California Institute of Tech.



HQ # 79-H-361
79-HC-259

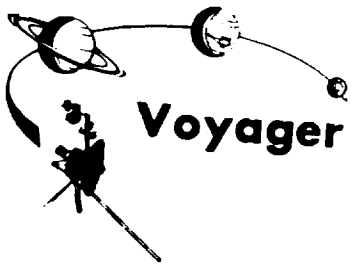
This photo from Voyager 2 was taken on June 9, 1979, and is centered over the long-lived disturbed region west of the Great Red Spot (GRS). Note that the white oval to the lower left of the GRS has a similar chaotic region of clouds to its west. This particular white oval, which is not the same one as that seen below the GRS by Voyager 1 in March 1979, is moving to the right relative to the Red Spot. By the time of Voyager 2's closest approach to Jupiter on July 9, 1979, this oval will lie just south of the GRS. At the time this composite was taken, the spacecraft was over 24 million kilometers (15 million miles) from Jupiter. The smallest features which can be seen are roughly 450 kilometers (280 miles) across.





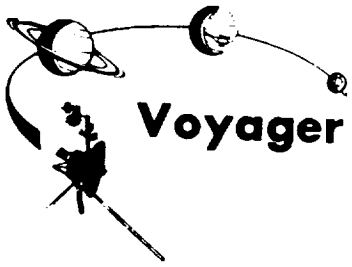
HQ # 79-H-362
79-HC-260

This picture of Jupiter was taken by Voyager 2 on June 10, 1979, from a distance of 24 million kilometers (15 million miles). On top of Jupiter's brightly colored cloud patterns is the shadow of Ganymede, the largest of the Jovian satellites. Io, the innermost of the large satellites, is visible to the right of Jupiter. This satellite has been found to be the most volcanically active body so far discovered in the solar system. Plumes of volcanic material erupting as high as 280 kilometers (174 miles) above the surface have been found. These features are not yet visible in the Voyager 2 pictures but will soon be studied at high resolution as Voyager makes its closest approach to the Jovian system on July 9, 1979.



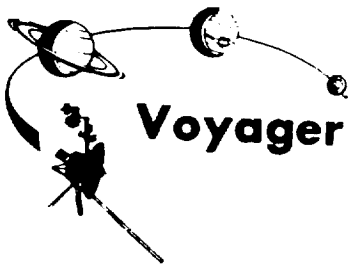
HQ # 79-H-363
79-HC-261

This photograph of the southern hemisphere of Jupiter was obtained by Voyager 2 on June 25, 1979, at a distance of 12 million kilometers (8 million miles). The Voyager spacecraft is rapidly nearing the giant planet, with closest approach to occur at 4:23 p.m. PDT on July 9. Seen in front of the turbulent clouds of the planet is Io, the innermost of the large Galilean satellites of Jupiter. Io is the size of our Moon. Voyager discovered in early March that Io is the most volcanically active planetary body known in the solar system, with continuous eruptions much larger than any that take place on the Earth. The red, orange, and yellow colors of Io are thought to be deposits of sulfur and sulfur compounds produced in these eruptions. The smallest features in either Jupiter or Io that can be distinguished in this picture are about 200 kilometers (125 miles) across; with this resolution, it is not yet possible to identify individual volcanic eruptions. Monitoring of the erupture activity of Io by Voyager 2 will begin about July 5 and will extend past the encounter on July 9. The Voyager Project is managed for NASA by the Jet Propulsion Laboratory.



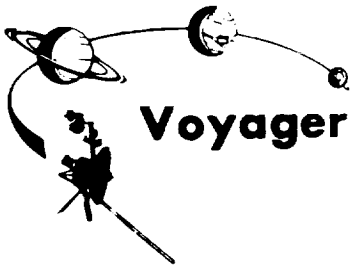
HQ # 79-H-365
79-HC-263

This special color composite made from Voyager 2 narrow-angle frames taken on June 28, 1979, has been processed to exaggerate color differences within the naturally colorful Jovian atmosphere. Such processing makes detailed structure in the clouds more apparent. The dark belt across the upper portion of the photograph is the North Equatorial Belt. One of the largest of the long-lived dark features found along the northern edge of this belt is seen in the upper middle of the photograph. Jupiter's Equatorial Zone, which lies across the middle of the photograph, is characterized by a series of wisp-like plume features. The northern bluish edges of these plumes are thought to lie within deeper, warmer levels of the atmosphere. South of the Equatorial Zone lies the chaotic region of whiter clouds found west of the Great Red Spot. At the time this photograph was taken, Voyager 2 was 10.3 million kilometers (6.4 million miles) from Jupiter. The smallest features visible in this photograph are about 190 kilometers (119 miles) across.



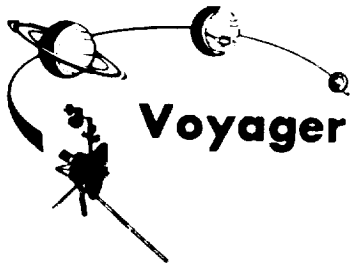
HQ # 79-HC-80
79-H-107

This large brown oval, photographed on March 2 by Voyager 1, is located between 13 and 18 degrees N latitude and may be an opening in the upper cloud deck which, if observed at extremely high resolution, could provide information about deeper, warmer cloud levels; therefore, it has been selected as one of the targets to be photographed on March 5 near closest approach to Jupiter. Features of this sort are not rare on Jupiter and have an average lifetime of one to two years. Above the feature is the pale orange North Temperate Belt, bounded on the south by the high-speed North Temperate Current with winds of 120 meters/sec (260 mi/hr). The range to Jupiter at the time this photograph was obtained was 4.0 million kilometers (2.5 million miles), with the smallest resolvable features being 75 kilometers (45 miles) wide.



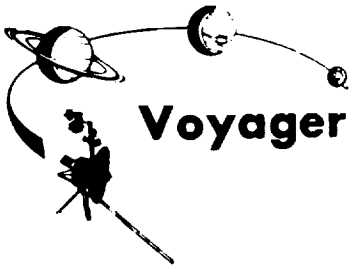
HQ # 79-HC-264
79-H-366

This color composite made from Voyager 2 narrow-angle camera frames shows the Great Red Spot during the late Jovian afternoon. North of the Great Red Spot lies a curious darker section of the South Equatorial Belt (SEB), the belt in which the Great Red Spot is located. A bright eruption of material passing from the SEB northward into diffuse equatorial clouds has been observed on all occasions when this feature passes north of the Red Spot. The remnants of one such eruption are apparent in this photograph. To the lower left of the Red Spot lies one of the three long-lived white ovals. This photograph was taken on June 29, 1979, when Voyager 2 was over nine million kilometers (nearly six million miles) from Jupiter. The smallest features visible are over 170 kilometers (106 miles) across.



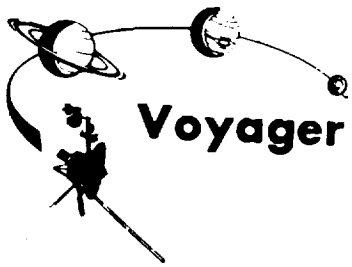
HQ # 79-H-367
79-HC-265

This image was obtained on June 29, 1979, when Voyager 2 was 9.3 million kilometers (5.6 million miles) from the planet. The view extends from +40 degrees to -40 degrees latitude with the size of the smallest discernible features equal to 172 kilometers (106 miles). The broad orange band extending across the lower half of the picture is the equatorial region of the planet. All brown and white oval-shaped clouds visible in this image were observed by Voyager 1 in early March, illustrating the stability of this type of feature in the Jovian atmosphere. The turbulent region in the lower right-hand corner lies to the west of the Great Red Spot. High-velocity westward winds along the southern edge combine with eastern winds along the northern edge to produce the observed effect. These individual features are short-lived.



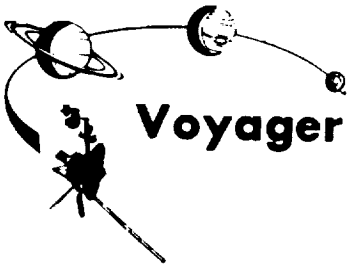
HQ # 79-H-368
79-HC-266

This Jupiter image taken by Voyager 2 shows an area from 10 degrees N lat. to 34 degrees S lat. in a region west of the Great Red Spot. At the top of the picture, equatorial plumes are seen. These features move along the edge of the equatorial band. The remainder of the equatorial region is characterized by diffuse clouds. The region west of the Great Red Spot is seen as a disturbed, wave-like pattern. Similar flows are seen to the west of the white oval at bottom.



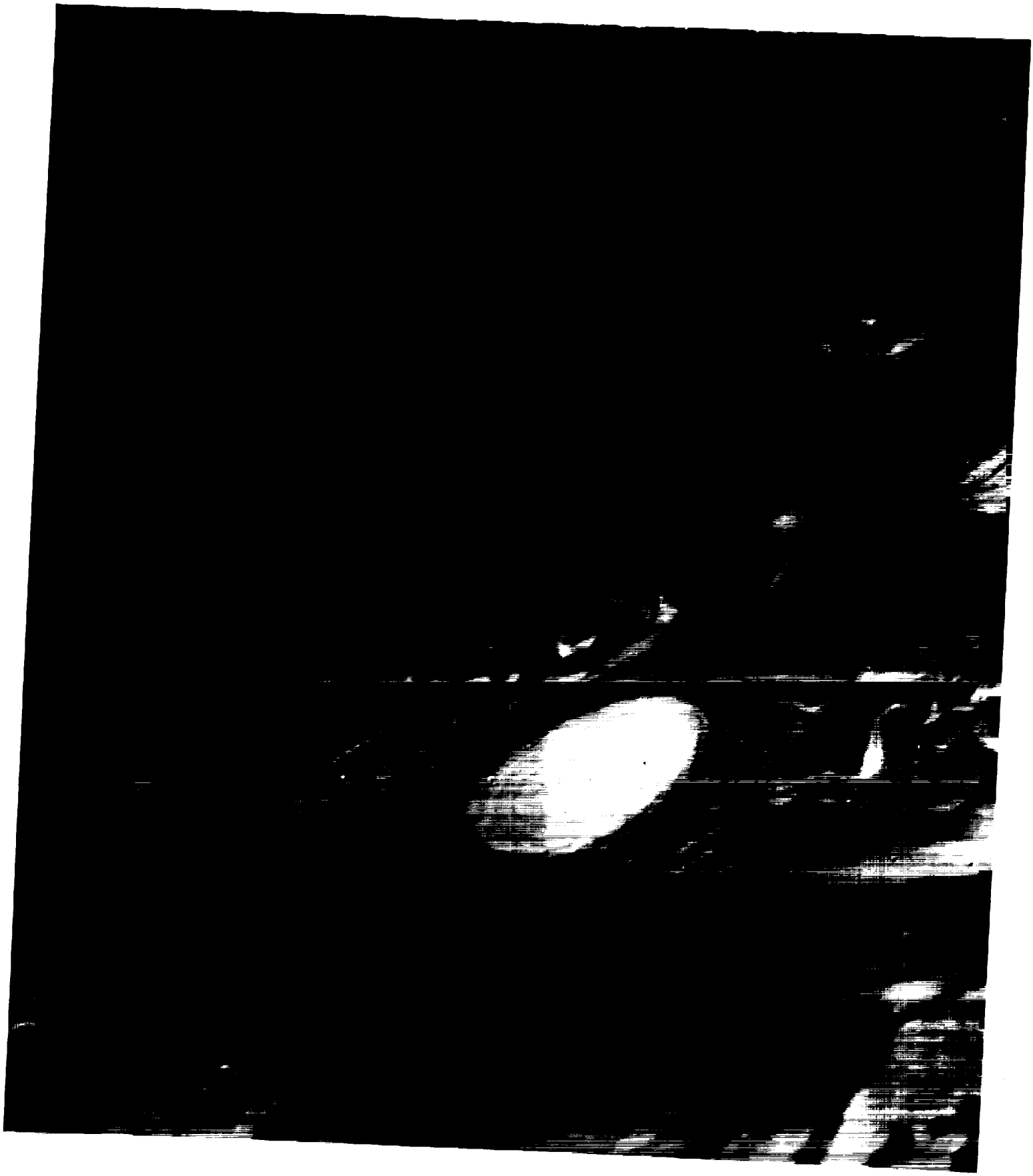
HQ # 79-H-369
79-HC-267

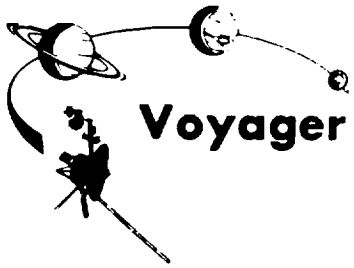
This Voyager 2 picture shows the Great Red Spot and the South Equatorial Belt extending into the equatorial region. At right is an interchange of material between the South Equatorial Belt and the Equatorial Zone. The clouds in the Equatorial Zone are more diffuse and do not display the structures seen in other locations. Considerable structure is evident within the Great Red Spot.



HQ # 79-HC-268
79-H-370

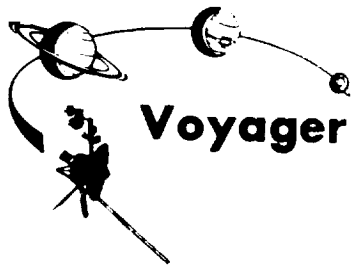
This picture shows a region of the southern hemisphere extending from the Great Red Spot to the south pole. The white oval is seen beneath the Great Red Spot, and several small-scale spots are visible farther to the south. Some of these organized cloud spots have similar morphologies, such as anticyclonic rotations and cyclonic regions to their west. The presence of the white oval causes the streamlines of the flow to bunch up between the oval and the Great Red Spot.





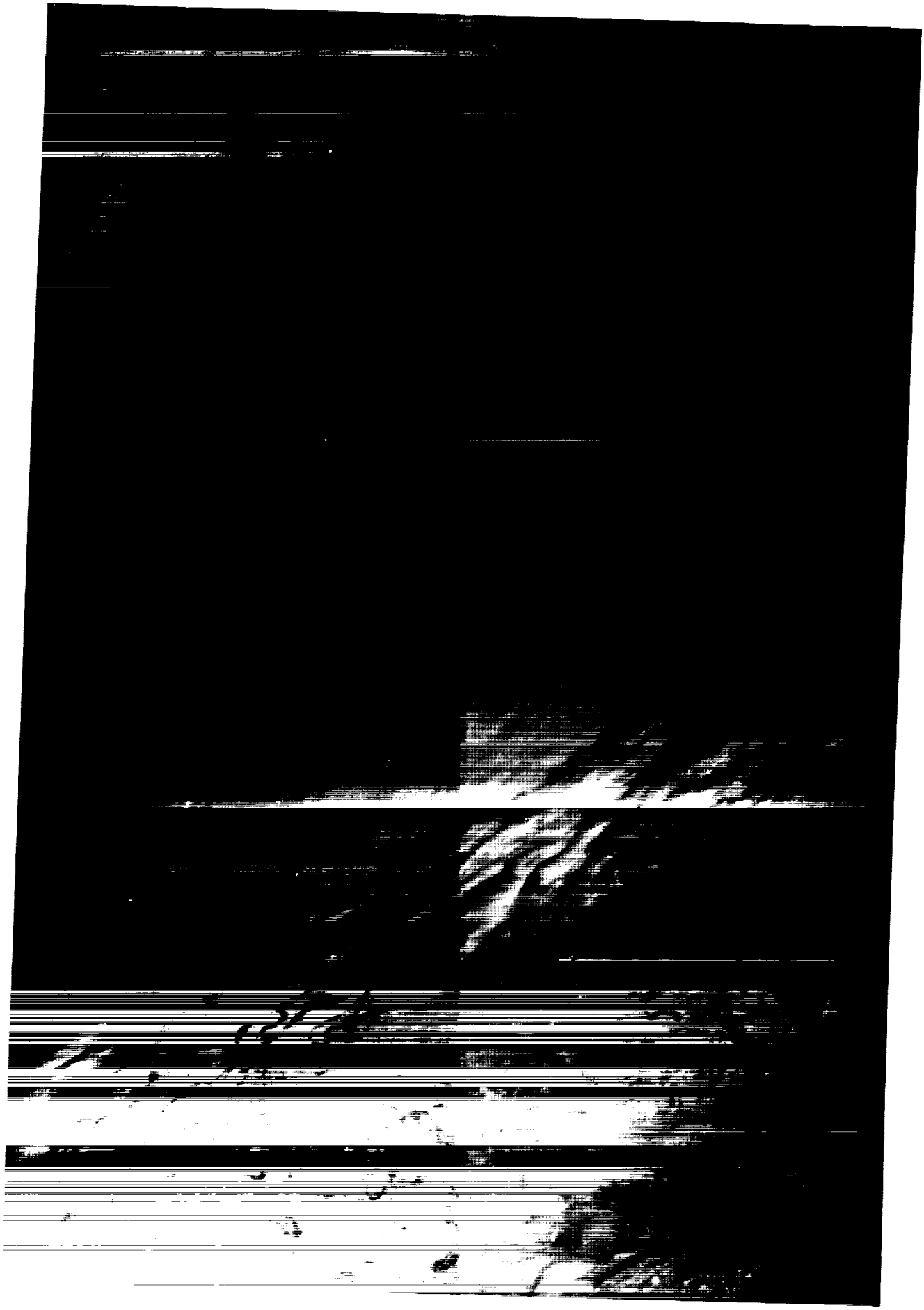
HQ # 79-HC-271
79-H-375
JPL # P-21742 B/W

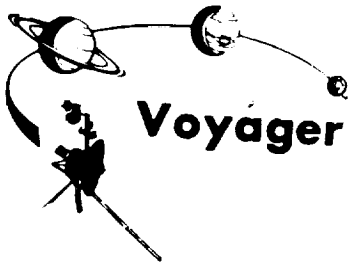
This Voyager 2 image shows the region of Jupiter extending from the equator to the southern polar latitudes in the neighborhood of the Great Red Spot. A white oval, different from the one observed in a similar position at the time of the Voyager 1 encounter, is situated south of the Great Red Spot. The region of white clouds now extends from east of the red spot and around its northern boundary, preventing small cloud vortices from circling the feature. The disturbed region west of the red spot has also changed since the equivalent Voyager 1 image. It shows more small-scale structures and cloud vortices being formed out of the wave structures. The picture was taken on July 3 from six million kilometers (3.72 million miles).



HQ # 79-HC-273
79-H-379

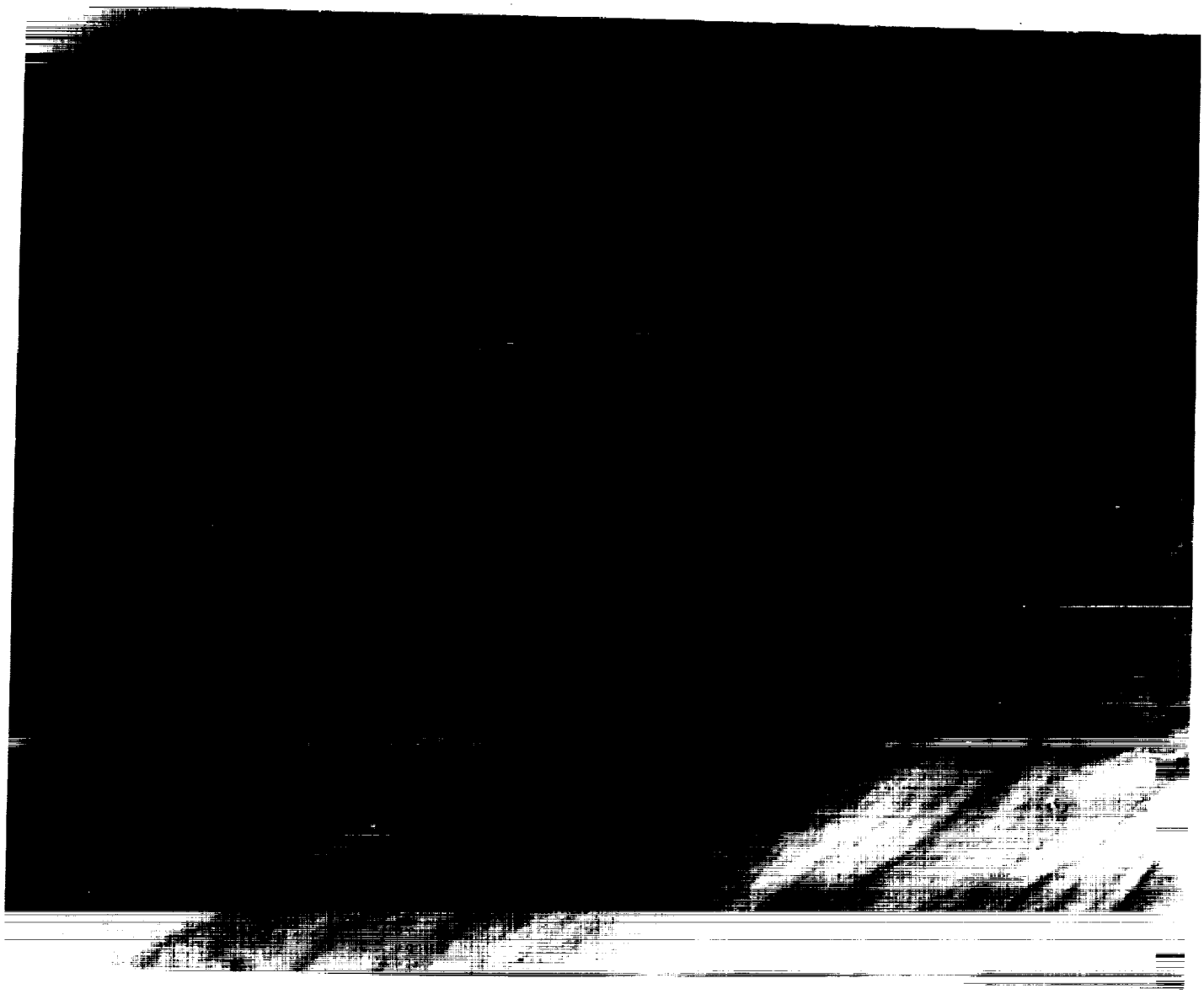
This image, taken on July 6 at a range of 3,500,000 kilometers (2,200,000 miles) shows a region of the Jovian atmosphere from approximately 25 degrees N to the equatorial region. The north temperate jet, at approximately 23 degrees N, where the wind speed is about 250 meters per second, is seen as a dark brown line from the left edge to the upper right-hand corner of the picture. The wispy clouds of the North Equatorial Belt appear as shades of brown. The lower right-hand corner of the image shows the brighter (white) clouds of the equatorial region. A small blue area is apparent near the lower edge, corresponding to a region free of the upper clouds where it is possible to penetrate to cloud layers approximately 60 kilometers (37 miles) below the visible surface.

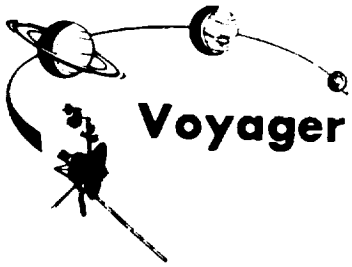




HQ # 79-H-385
79-HC-279

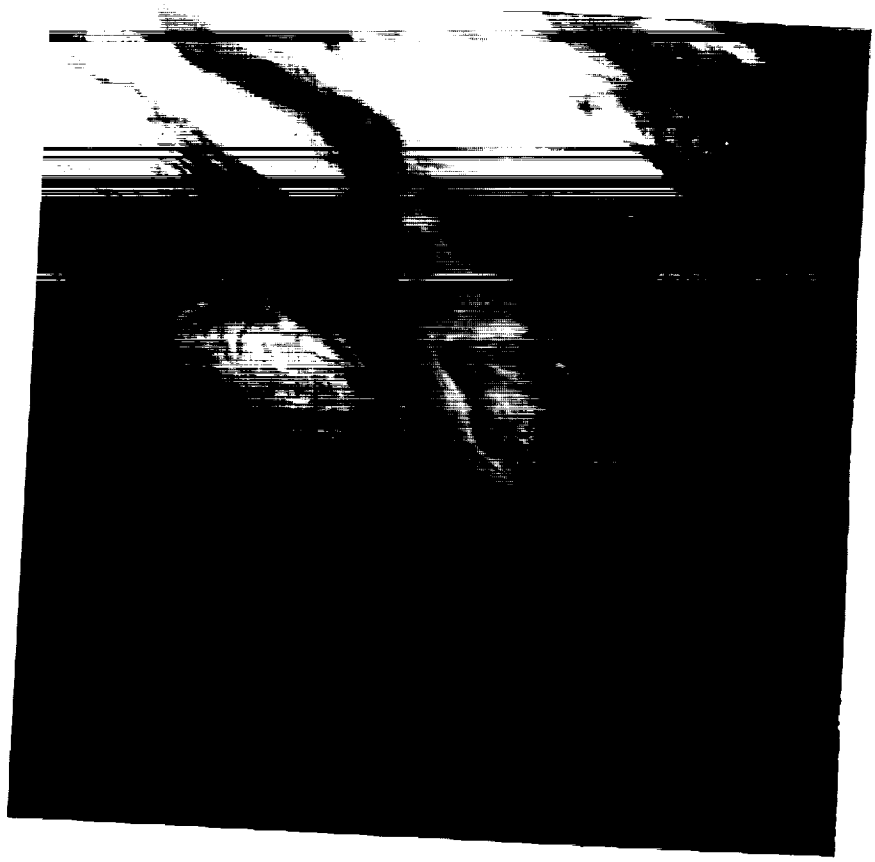
This image returned by Voyager 2 shows one of the long, dark clouds observed in the North Equatorial Belt of Jupiter. A high, white cloud is seen moving over the darker cloud, providing an indication of the structure of the cloud layers. Thin white clouds are also seen within the dark cloud. At right, blue areas, free of high clouds, are seen. This photo was taken on July 6 from a distance of 3.2 million kilometers (2 million miles).

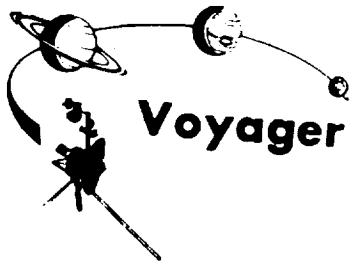




HQ # 79-H-386
79-HC-280

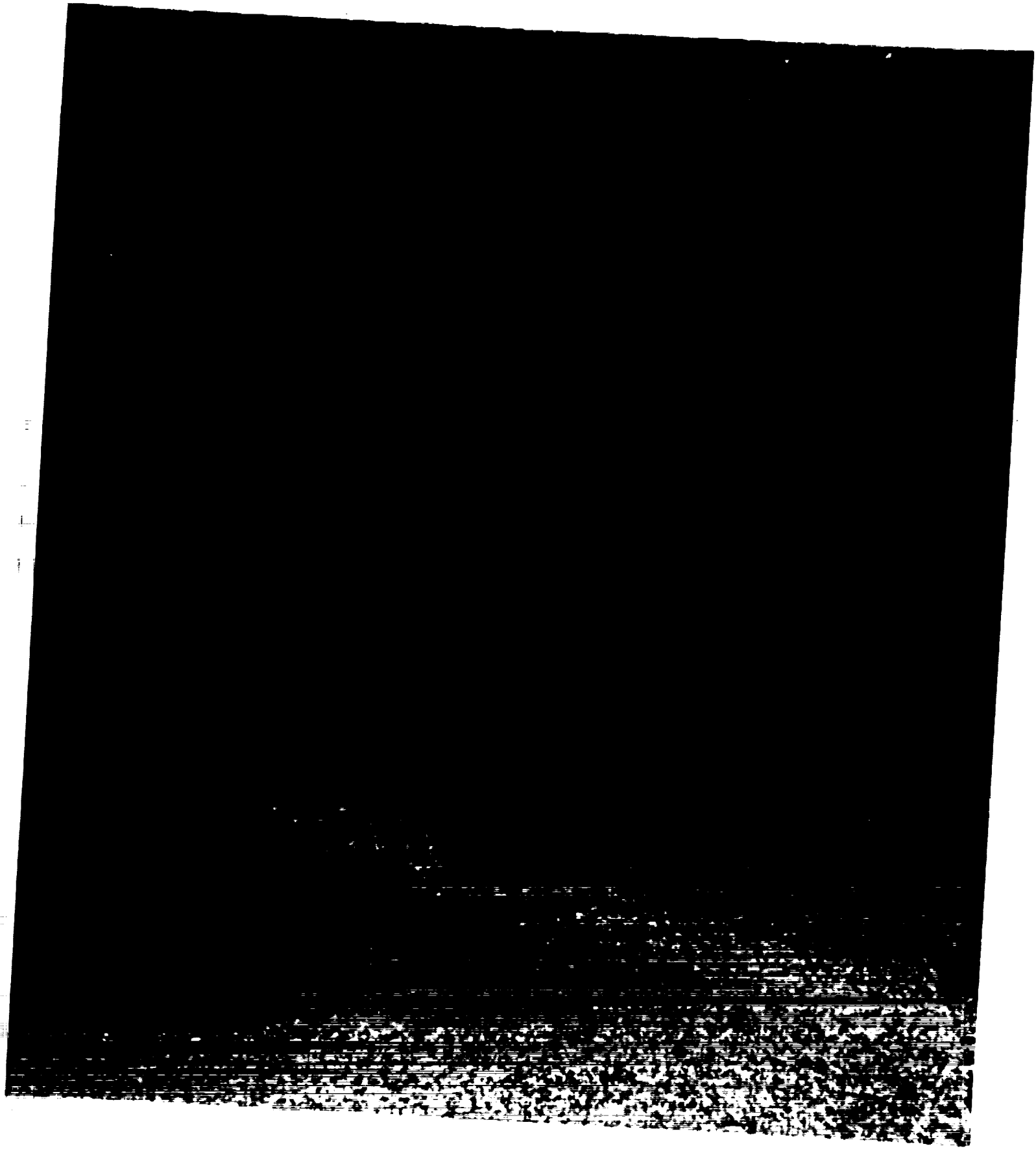
This pair of images shows two of the long-lived white oval clouds which have resided in the Jovian southern hemisphere for nearly 40 years. The upper picture shows the cloud that is at a longitude west of the Great Red Spot, and the lower frame, the cloud at a longitude east of this feature. The third oval is currently just south of the Great Red Spot. The clouds show very similar internal structures. To the east of each of them, recirculating currents are clearly seen. In the lower frame, similar structure is seen to the west of the cloud. Although a recirculating current is associated with the western region of the upper cloud, it is farther away from this feature and not seen in the image. This photo was taken on July 5 by Voyager 2 from a distance of 3.4 million kilometers (2.1 million miles).

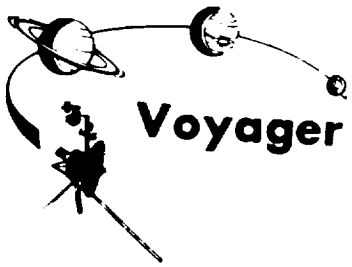




HQ # 79-HC-285
79-H-395

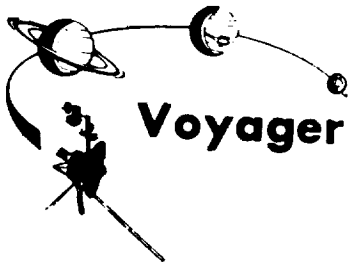
Jupiter's thin ring of particles was photographed by Voyager 2's telescope-equipped TV camera through three color filters to provide this color representation. The pictures were obtained from a range of 1,400,000 kilometers (870,000 miles) on July 8, 1979, about 23 hours prior to Voyager's closest approach to Jupiter. During the three long exposures the spacecraft drifted, smearing out the ring image. The linear feature just above the ring is a star trail. True color of the ring cannot be deduced from this photo.





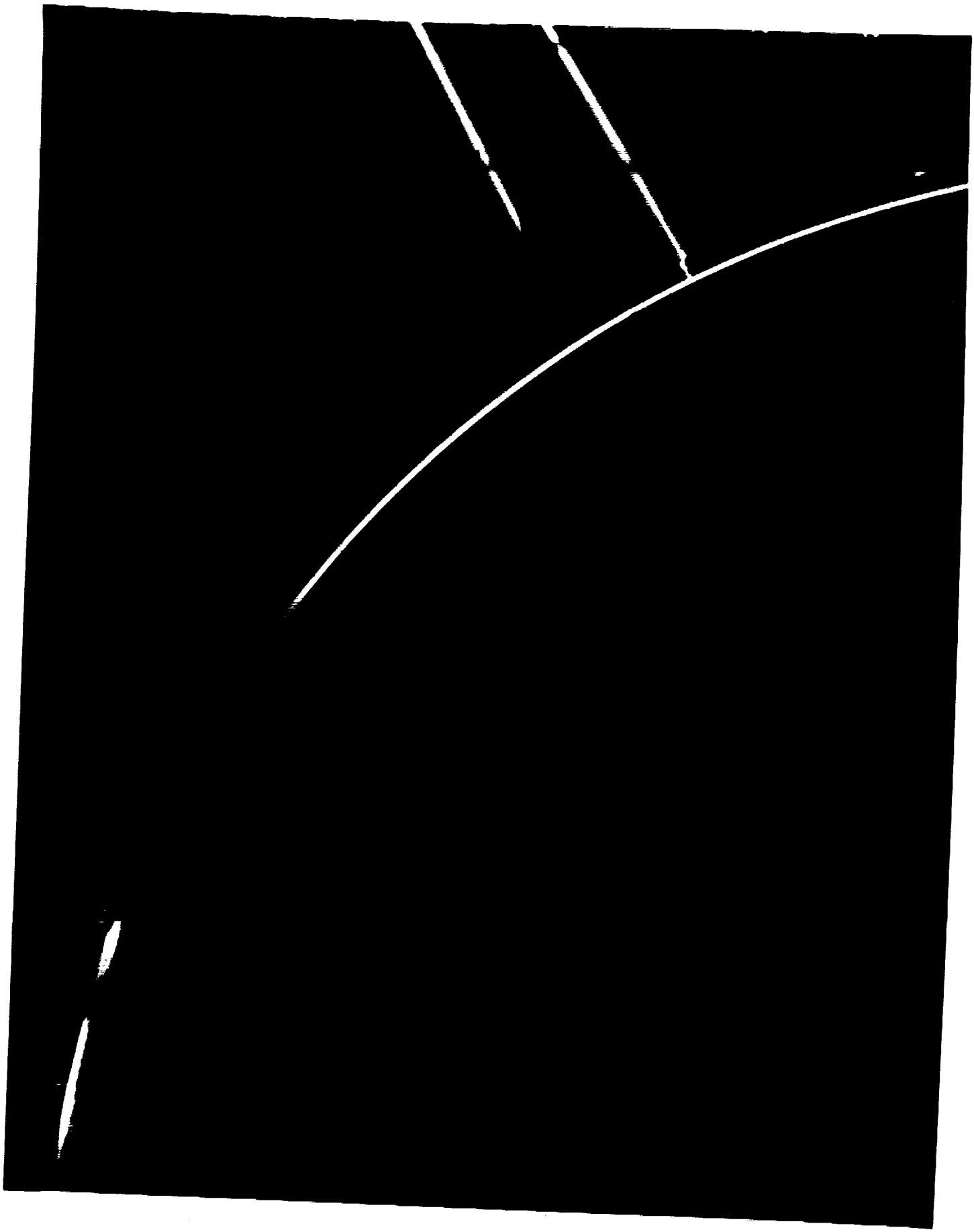
HQ # 79-H-501
79-HC-288

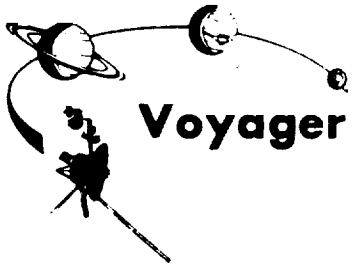
The cylindrical projections of Jupiter, representing both Voyager 1 (top) and Voyager 2 (bottom), are presented in this comparison. Top of photo is at left. The top picture extends 400 degrees longitude to 0 degrees (right edge). It is aligned with the lower image so that the longitude scale is correct for both frames. The comparison between the pictures shows the relative motions of features in Jupiter's atmosphere. It can be seen, for example, that the Great Red Spot has moved westward and the white oval features eastward during the time between the acquisition of these pictures. Regular plume patterns are equidistant around the northern edge of the equator, while a trail of small spots has moved eastward at approximately 80 degrees south latitude. In addition to these relative motions, significant changes are evident in the recirculating flow east of the Great Red Spot, in the disturbed region west of the Great Red Spot, and as seen in the brightening of material spreading into the equatorial region from the more southerly latitudes.



HQ # 79-HC-296
79-H-517

Jupiter's faint ring system is shown in this color composite as two light orange lines protruding from the left toward Jupiter's limb. This picture was taken in Jupiter's shadow through orange and violet filters. The colorful images of Jupiter's bright limb are evidence of the spacecraft motion during these long exposures. The Voyager 2 spacecraft was at a range of 1,450,000 km (900,000 miles) about two degrees below the plane of the ring. The lower ring image was cut short by Jupiter's shadow on the ring.

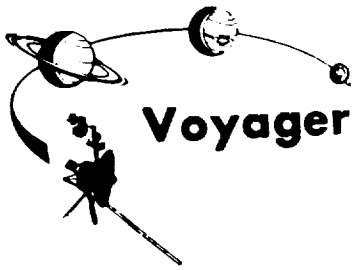




HQ # 79-HC-297
79-H-518

This mosaic of the Great Red Spot shows that the region has changed significantly since the Voyager 1 encounter three months ago. Around the northern boundary a white cloud is seen which extends to the east of the region. The presence of this cloud prevents small cloud vortices from circling the spot in the manner seen in the Voyager 1 encounter. Another white oval cloud (different from the one present in this position three months ago) is seen south of the Great Red Spot. The internal structure of these spots is identical. Since they both rotate in an anticyclonic manner, these observations indicate that they are meteorologically similar. This image was taken on July 6 from a range of 2,633,000 kilometers (1,632,000 miles).

C-2.



HQ # 79-H-84

This mosaic of Jupiter was assembled from nine individual photos taken through an orange filter by Voyager 1 on February 26, 1979, when the spacecraft was 7.6 million kilometers (4.7 million miles) from Jupiter. Distortion of the mosaic, especially where portions of the limb have been fitted together, is caused by rotation of the planet during the 96-second intervals between individual pictures. The large atmospheric feature just below and to the right of center is the Great Red Spot. The complex structure of the cloud formations seen over the entire planet gives some hint of the equally complex motions in the Voyager 1 time-lapse photography. The smallest atmospheric features seen in this view are approximately 140 kilometers (85 miles) across. Voyager will makes its closest approach to Jupiter on March 5.

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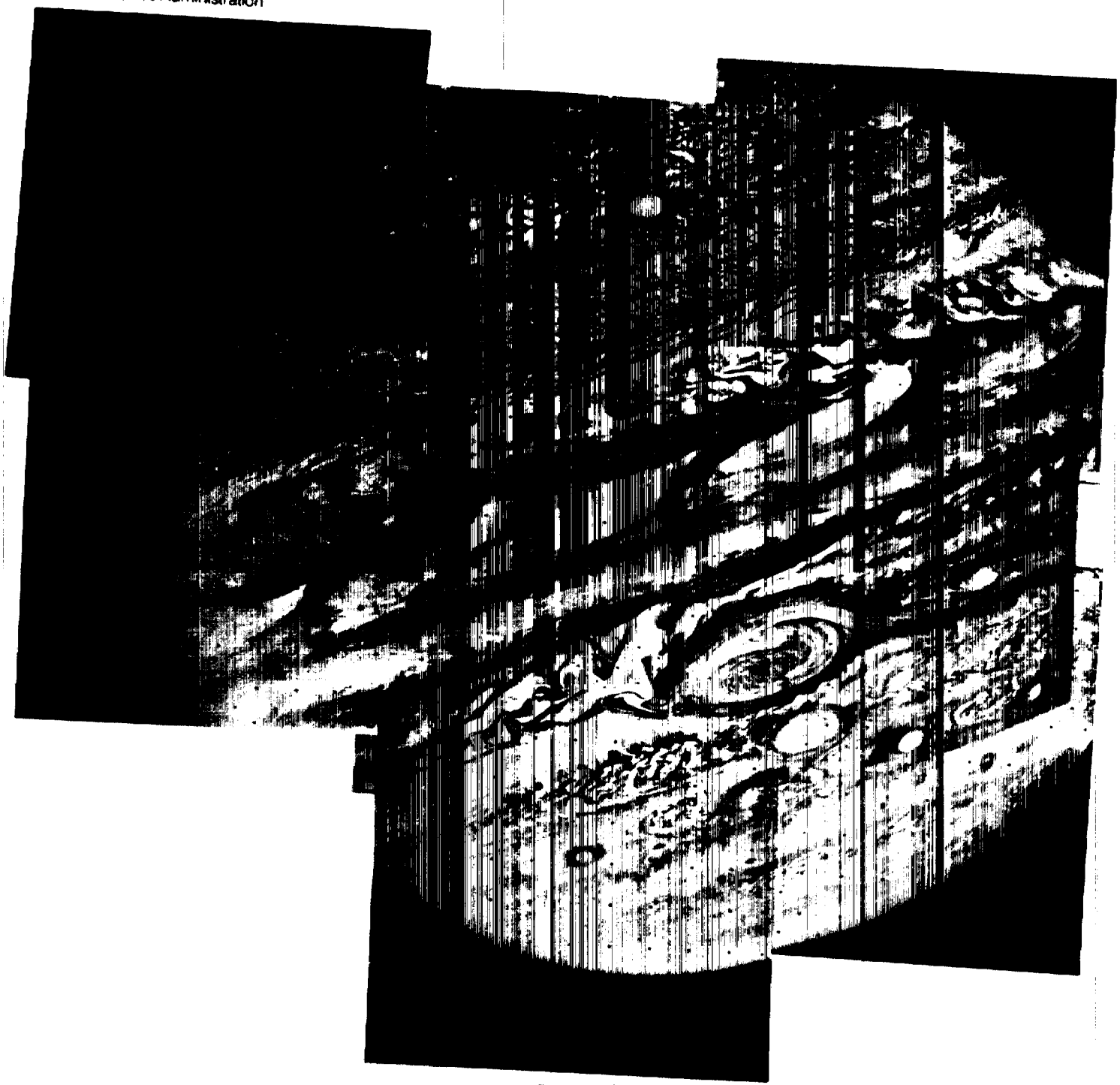
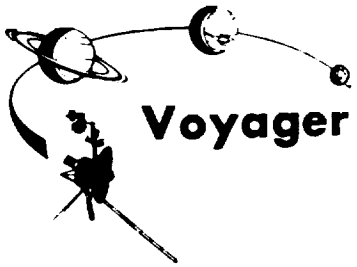
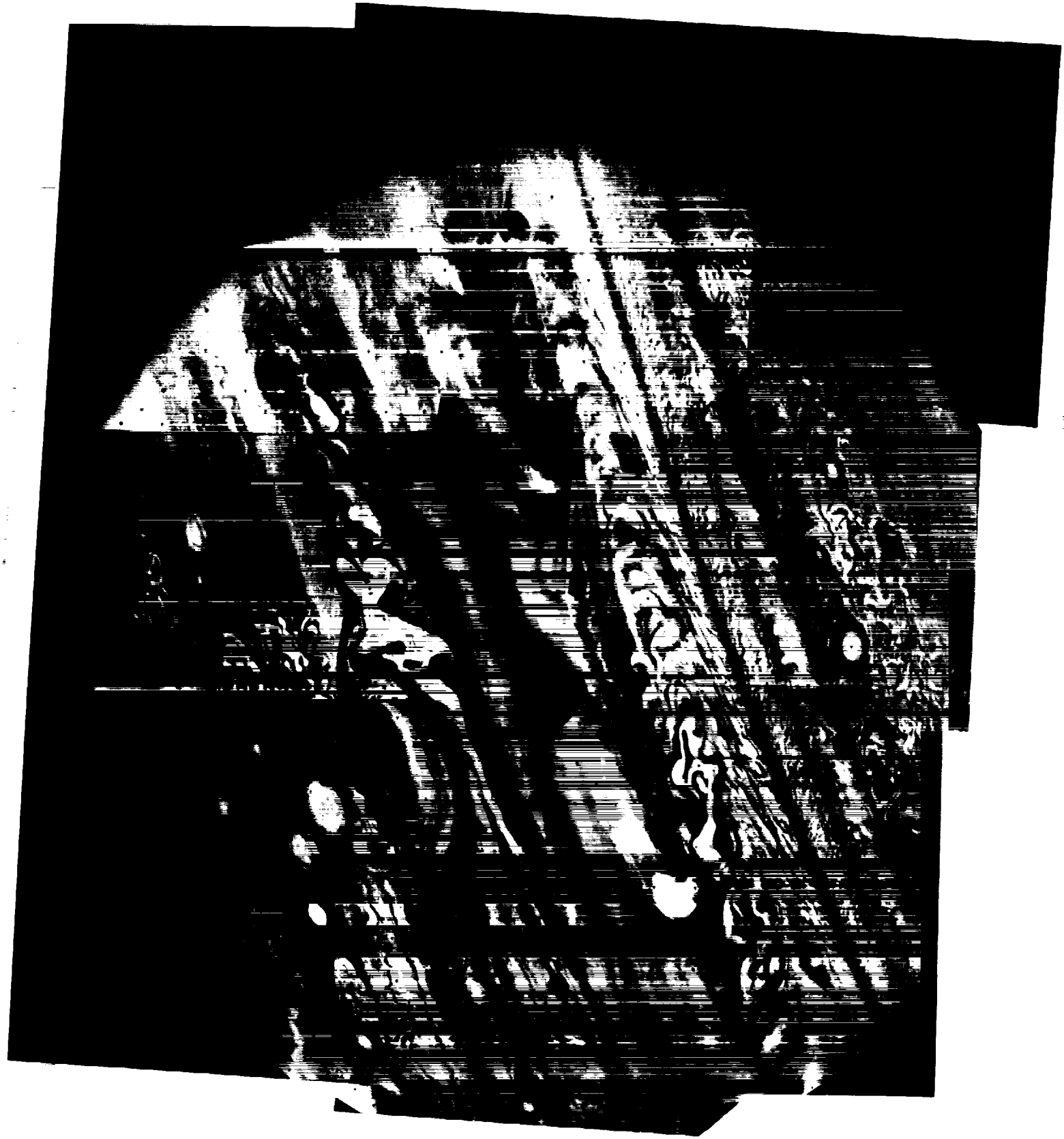
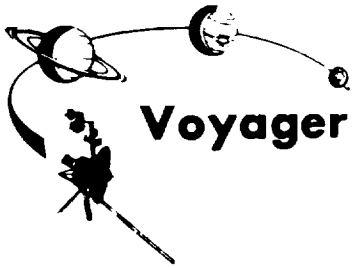




HQ # 79-H-85

This mosaic of Jupiter has been assembled from nine individual photos taken through a violet filter by Voyager 1 on February 26, 1979. At the time, the spacecraft was 7.6 million kilometers (4.7 million miles) from Jupiter, heading toward a March 5 encounter. Distortion of the mosaic, especially noticeable where portions of the limb have been fitted together, is caused by rotation of the planet during the 96-second intervals between individual frames. The large atmospheric feature just below and to right of center is the Great Red Spot. The complex structure of the cloud formations seen over the entire planet gives some hint of the equally complex motions in the Voyager time-lapse photography. The smallest atmospheric features seen in this view are approximately 140 kilometers (85 miles) across.





HQ # 79-H-86

These four pictures of Jupiter's Great Red Spot were taken February 2 and 3, 1979, when Voyager 1 was about 31 million kilometers (19.4 million miles) from Jupiter. The pictures were taken one Jupiter rotation apart, so that together they depict four days in the life of the centuries-old Red Spot. The pictures clearly demonstrate changes in circulation around the Red Spot during the 40-hour period. The photos were taken through a blue filter.

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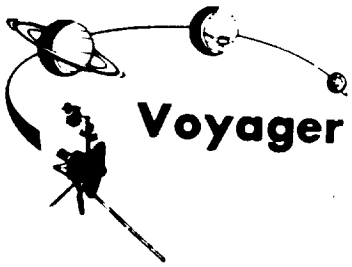
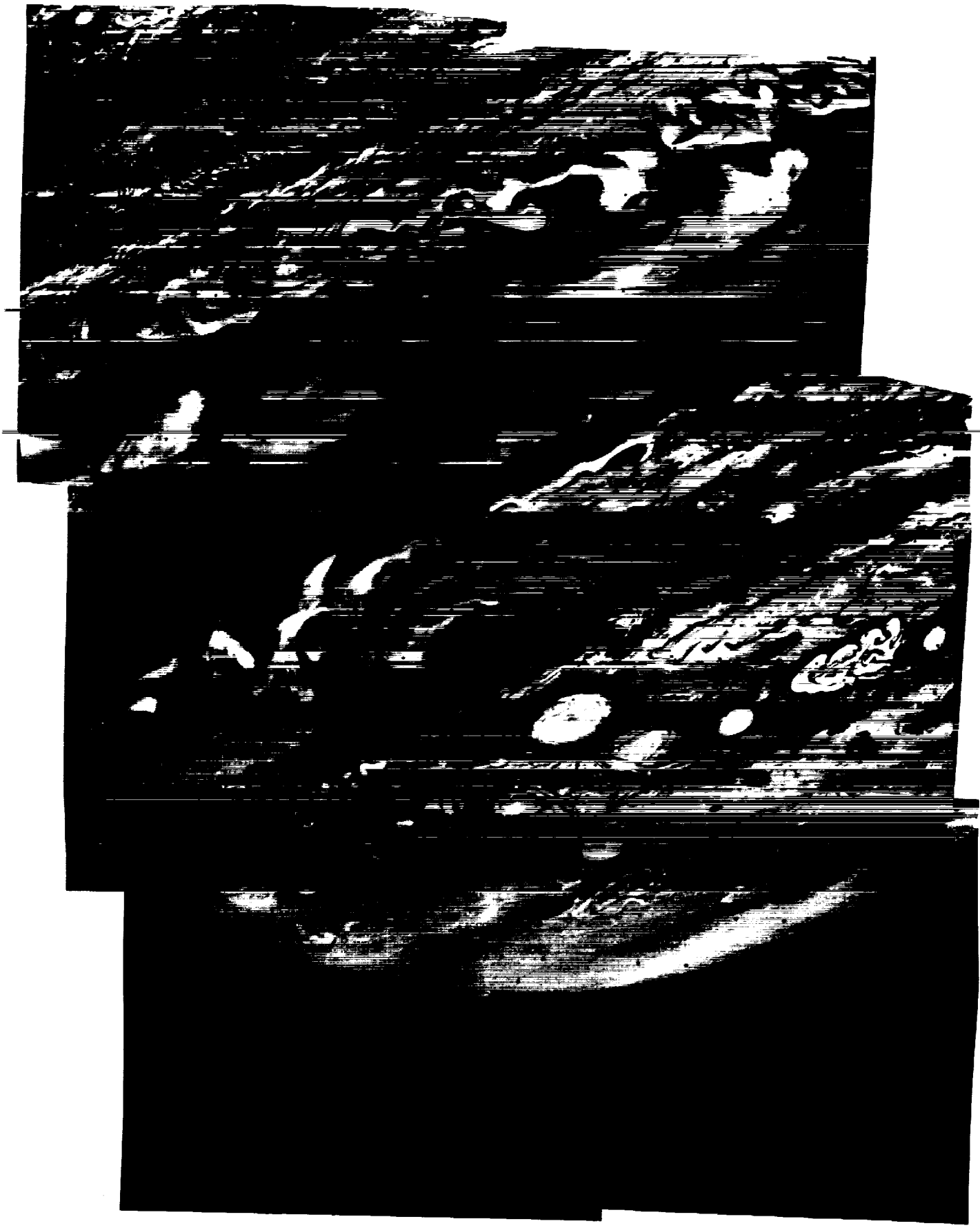
GREAT RED SPOT - ROTATIONS 67-70

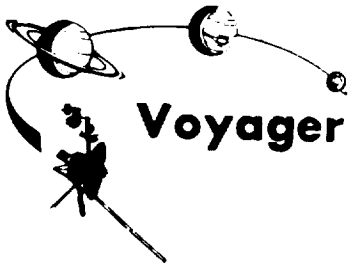
FEBRUARY 2 THROUGH FEBRUARY 3



HQ # 79-H-91

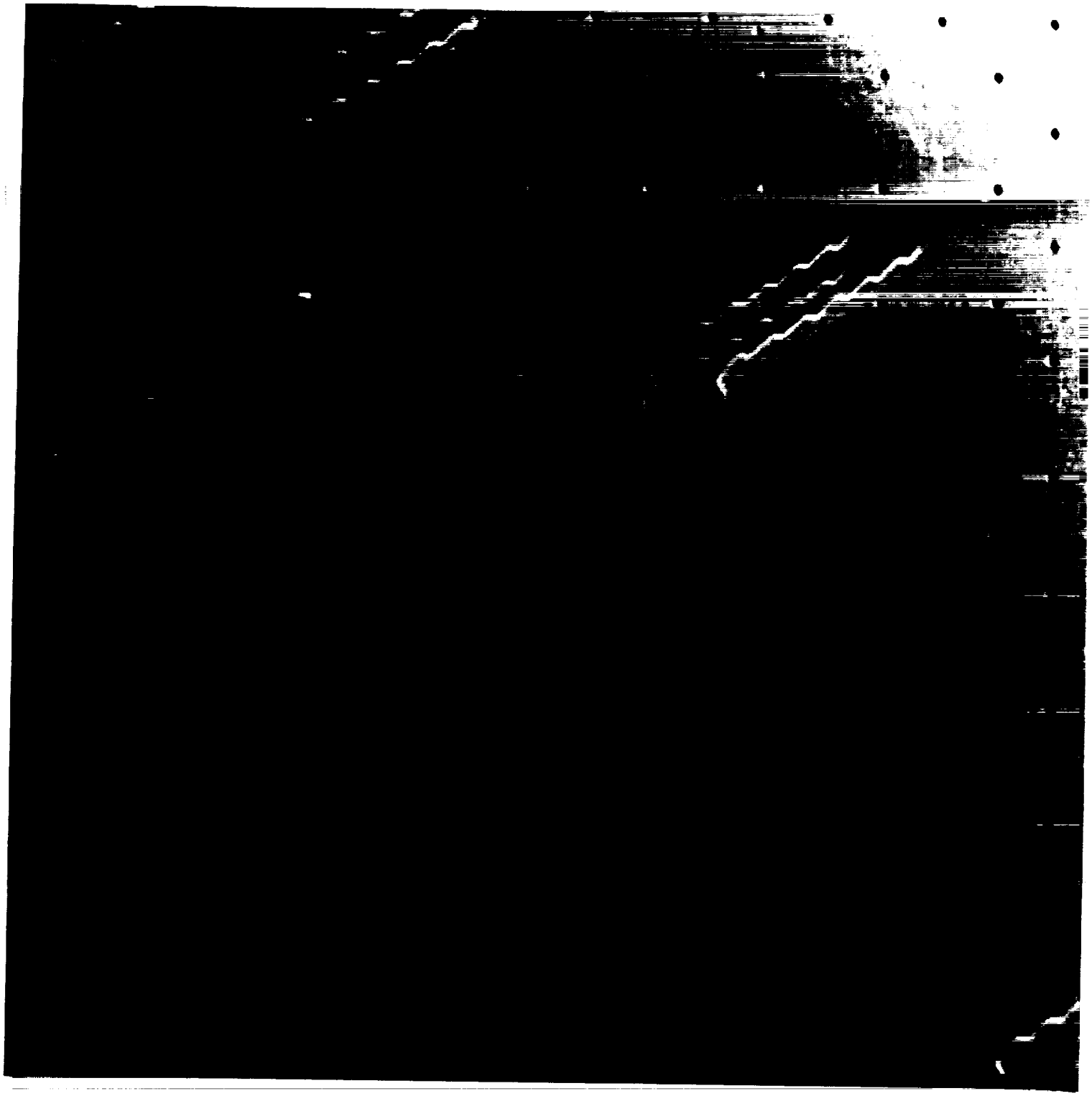
This mosaic was assembled from six violet images taken by Voyager 1 on February 27, 1979, at a distance of 6.5 million kilometers (4 million miles) from Jupiter. The swirling vortex-type motion, so apparent in the Great Red Spot (below the center of the mosaic) can also be seen in several nearby white clouds. These bright white clouds and the Great Red Spot are rotating in a counterclockwise direction. The peculiar filamentary cloud (to the right of the Great Red Spot) is circulating in a clockwise direction. The turbulence associated with the equatorial jet and more northerly atmospheric current is seen at the top of the picture. The smallest clouds seen in this mosaic are only 113 kilometers (70 miles) across.

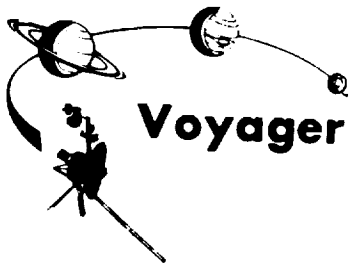




HQ # 79-H-110

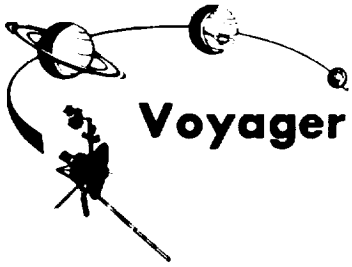
First evidence of a ring around the planet Jupiter is seen in this photograph taken by NASA's Voyager 1 on March 4, 1979. The multiple exposure of the extremely thin, faint ring appears as a broad light band crossing the center of the picture (top left to lower right). The edge of the ring is 1,212,000 kilometers (751,000 miles) from the spacecraft and 57,000 kilometers (35,000 miles) from the visible cloud deck of Jupiter. The background stars look like broken hairpins because of spacecraft motion during the 11 minute, 12 second exposure. The wavy motion of the star trails is due to the ultra-slow natural oscillation of the spacecraft (with a period of 78 seconds). The black dots are geometric calibration points in the camera. Thickness of the ring is estimated to be 30 kilometers (19 miles) or less. The photograph was part of a sequence planned to search for such rings in Jupiter's equatorial plane.





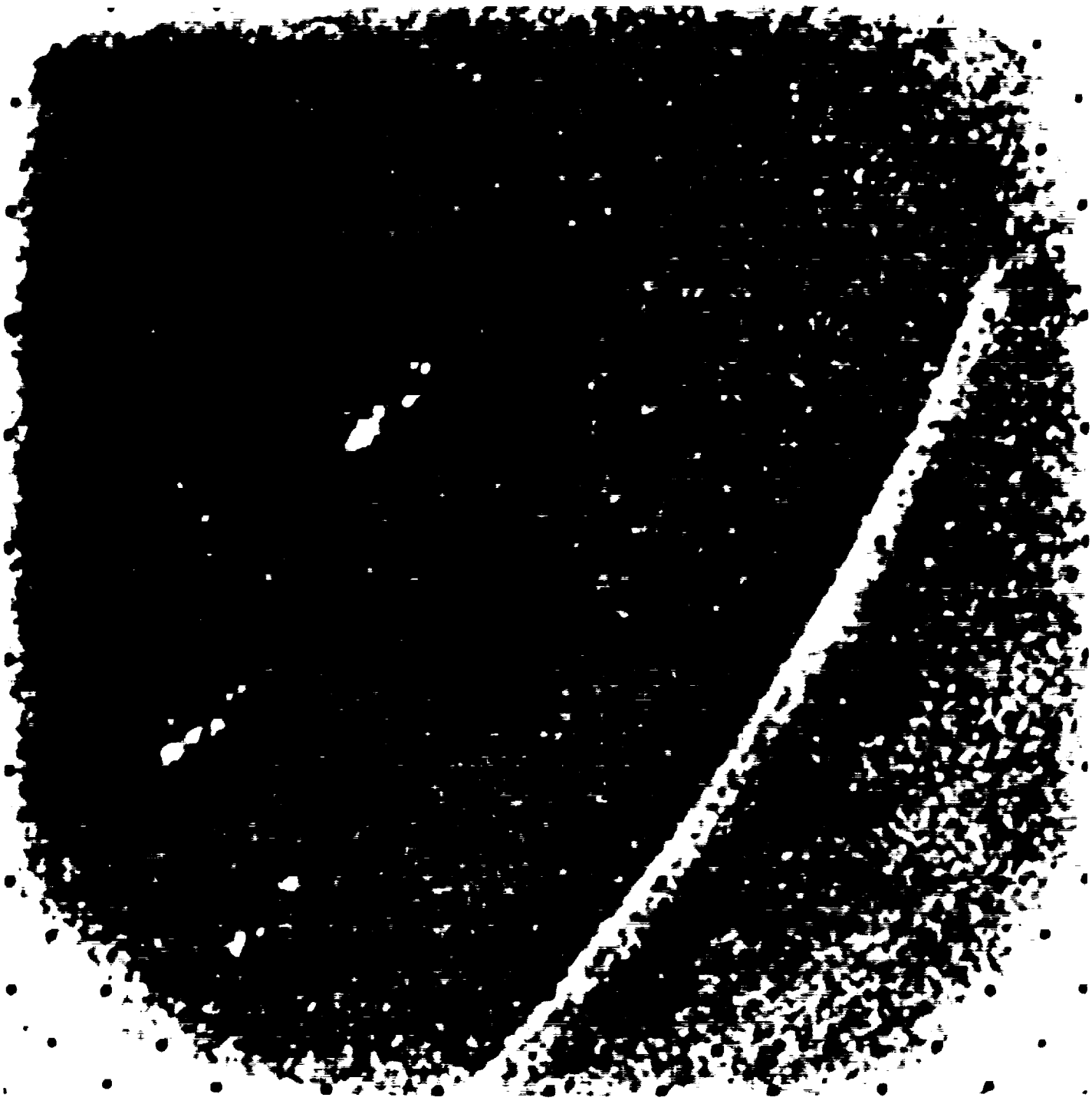
HQ # 79-H-118

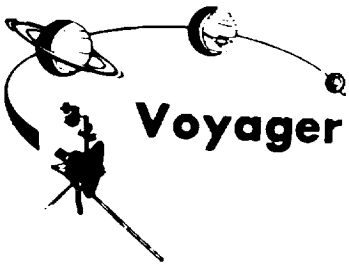
This mosaic of the Great Red Spot has been assembled from 12 orange filter pictures taken by Voyager 1 on March 4, 1979, at a distance of 1.8 million kilometers (1.1 million miles) from Jupiter. Although the periphery of the spot shows cloud streaming, which is characteristic of its counterclockwise circulation, the cloud patterns near the center suggest substantially reduced vorticity. Comparison of this view with others taken 10 hours earlier will provide a detailed picture of cloud motions both within the Great Red Spot and in its external environment. The smallest clouds visible in this view are 35 kilometers (20 miles) across.



HQ # 79-H-132

This Voyager 1 image was taken of Jupiter's dark side on March 5, 1979. The picture is a 3 minute, 12 second exposure taken by the wide-angle camera when the spacecraft was in Jupiter's shadow, about 6 hours after closest approach to the planet at a distance of 520,000 kilometers (320,000 miles). Jupiter's north pole is on the limb toward the upper center. The long, bright double streak is an aurora on Jupiter's limb near its north pole. The other bright spots probably are lightning but could be auroral features. The aurora's double structure may be real, or it may be caused by scan platform stepping during the exposure. The diagonal displacement of bright spots within each of the three active regions is due generally to scan platform stepping; but the patterns do not reproduce in detail, nor do they exhibit exactly the displacements of the camera during the exposure. As lightning flashes they would be comparable to the brightness of superbolts seen at the tops of terrestrial tropical thunderstorms. As auroral features they would have to be much brighter than those on Earth.





HQ # 79-H-389

Jupiter's thin ring of particles was photographed by Voyager 2 on its approach to the giant planet on July 8 from a range of two million kilometers (1.25 million miles). The spacecraft was 2.5 degrees above the plane of the ring. Segments of both sides of the faint ring were captured in this picture. The ring was first photographed in an edge-on configuration by Voyager 1 last March, and was measured then to have a radial extent of about 55,000 kilometers (34,000 miles) from Jupiter's cloud tops. With this picture, it is possible to determine that the ring is much narrower radially than the individual rings of Saturn. This image has had an extreme contrast enhancement process applied to it which brought out some white blotches in the central region and makes the ring appear discontinuous and non-uniform in brightness. These effects are all artifacts of the processing.

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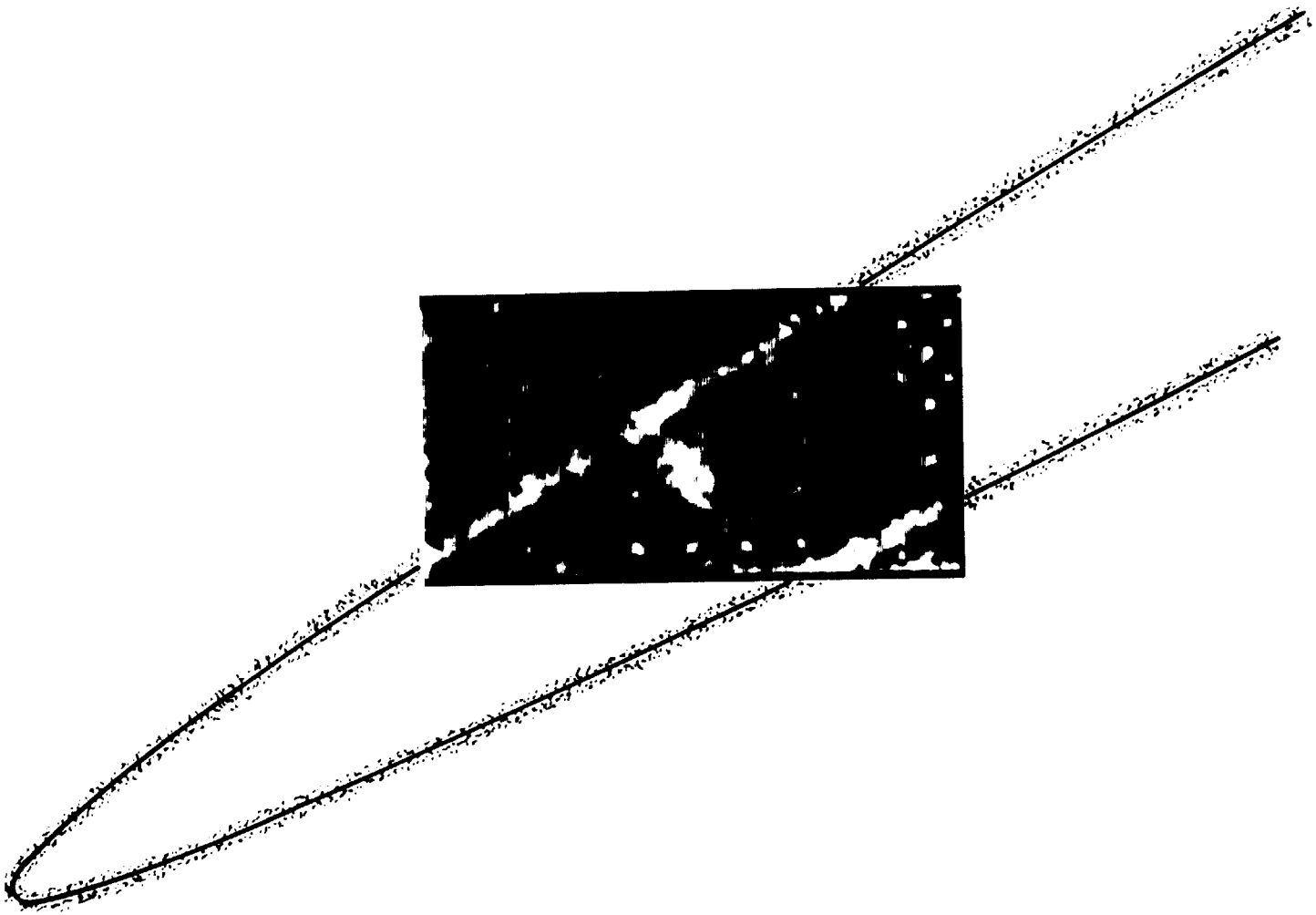
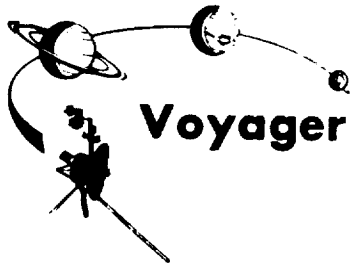
VOYAGER 2
JUPITER RING





HQ # 79-H-504

Voyager 2 took these high-resolution pictures of Jupiter's ring about 5:30 p.m. PDT on July 10, some 26 hours after flying past the planet. As the camera was shuttered, the spacecraft was two degrees below the ring plane and at a Jupiter range of 1,550,000 kilometers (961,000 miles). The forward scattering of sunlight reveals a radial distribution and density gradient of very small particles extending inward from the ring toward Jupiter. There is an indication of structure within the ring, but the spacecraft motion during these long exposures blurred out the highest resolution detail, particularly in the frame at right.

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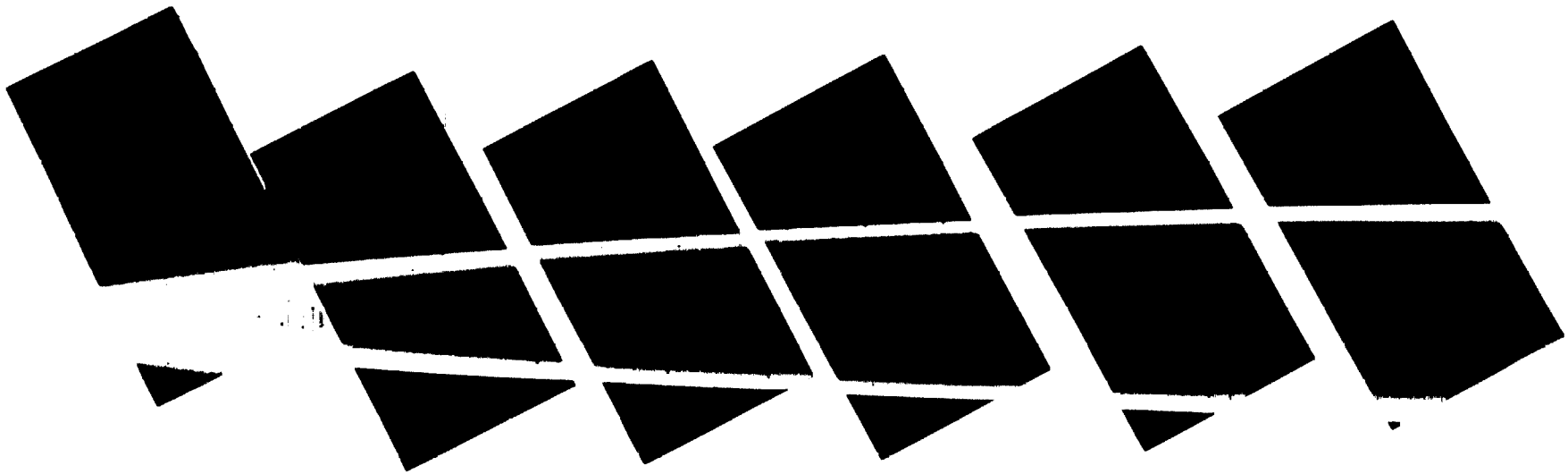

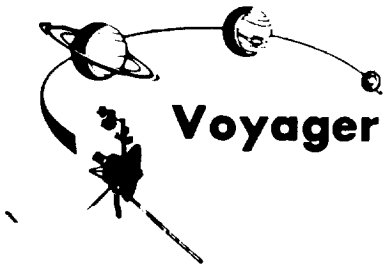

HQ # 79-H-505
JPL # P-21774

A brilliant halo around Jupiter, the thin ring of particles discovered four months ago by Voyager 1 is portrayed here by Voyager 2 from the planet's night side. This four-picture mosaic was obtained on July 10 with Voyager 2's wide-angle camera while the spacecraft was deep in Jupiter's shadow and some 560,000 kilometers (900,000 miles) beyond the planet. The ring is unusually bright because of forward scattering from small particles within it. Similarly, the planet is outlined by sunlight scattered toward the spacecraft from a haze layer high in Jupiter's atmosphere. On each side, the arms of the ring curving back toward the spacecraft are cut off by the planet's shadow as they approach the brightly outlined disk. The night side of Jupiter appears completely dark in this reproduction, but the pictures will be specially reprocessed to search for evidence of lighting storms and auroras.

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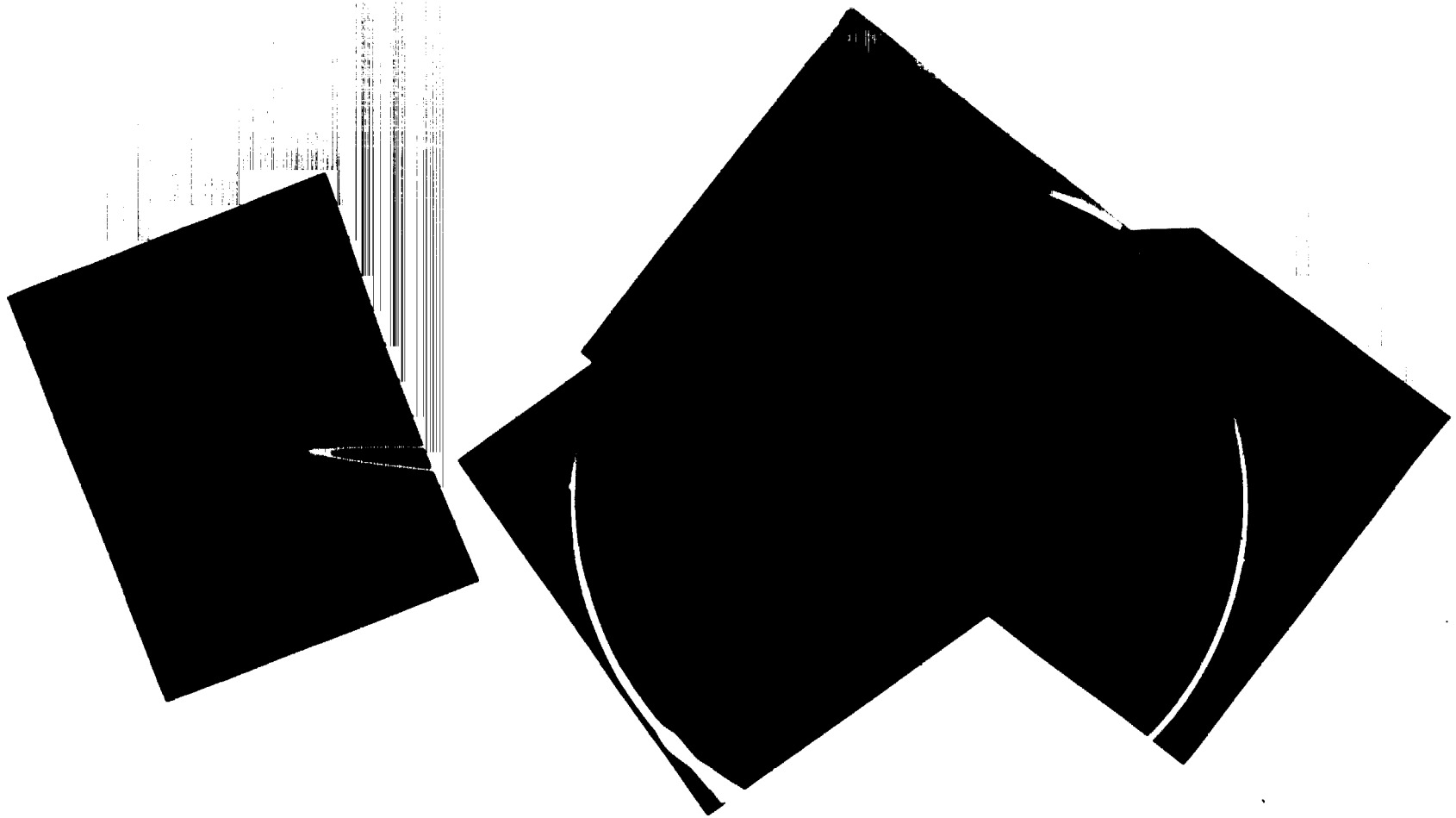
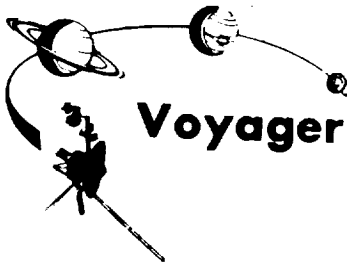
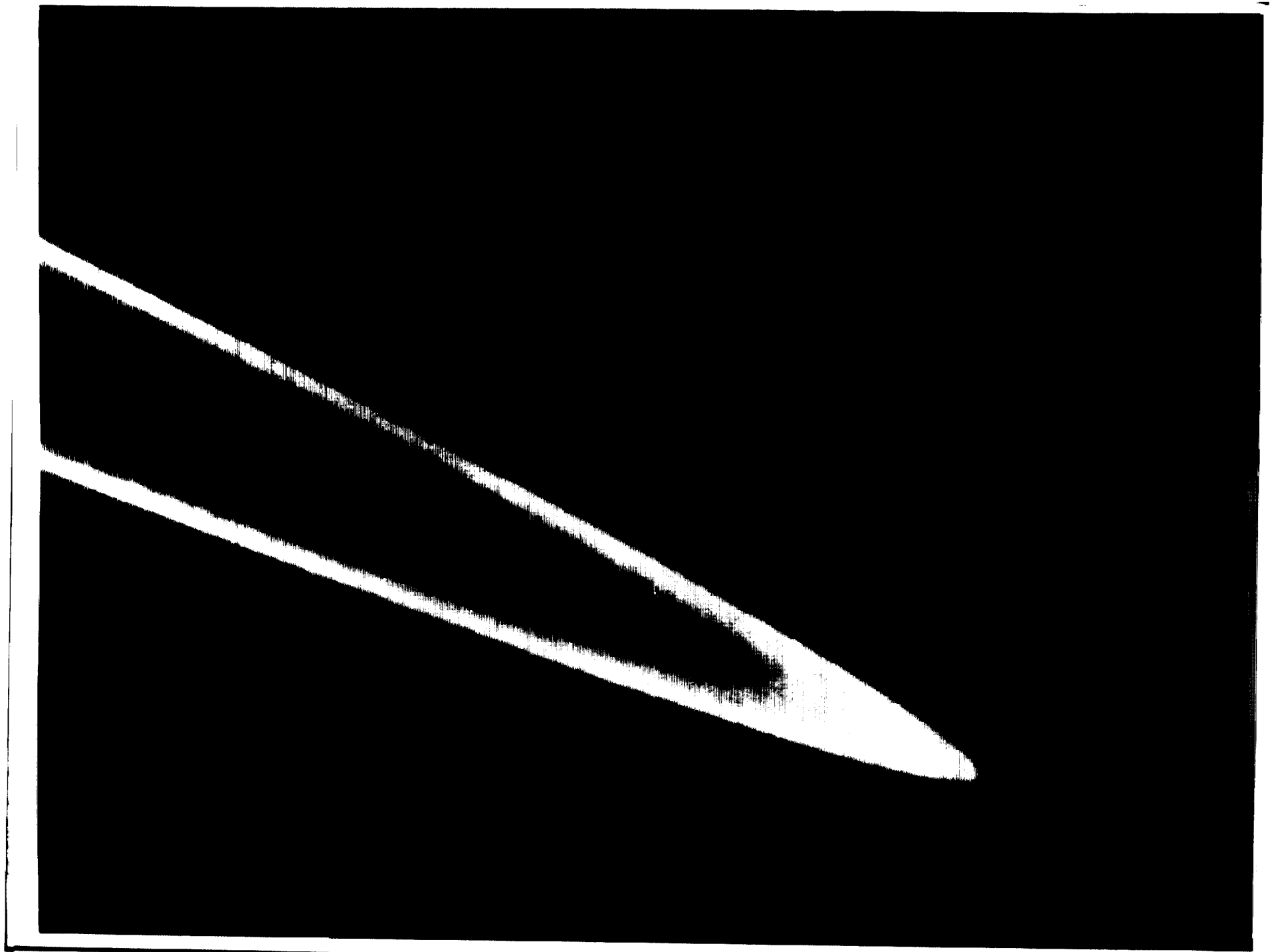
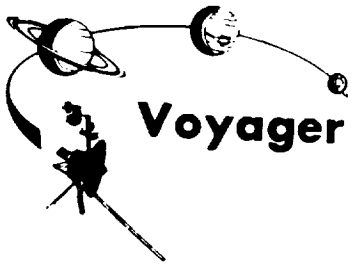




HQ # 79-H-507

This striking view of Jupiter's ring was recorded by Voyager 2 on July 10 at a distance of 1.5 million kilometers (930,000 miles). The unexpected brightness is probably due to forward scattering of sunlight by small ring particles. Seen within the inner edge of the brighter ring is a fainter ring which may extend all the way down to Jupiter's cloud tops. The ring was first discovered when photographed in March by Voyager 1.





HQ # 79-H-508

This high resolution view of Jupiter's ring suggests that it may be divided into several components, as are the rings of Saturn. The "V" shaped figure to the left is caused by a star image which was trailed out as the camera moved slightly during the long exposure. This image is part of a set obtained by Voyager 2 on July 10 at a distance of 1.5 million kilometers (930,000 miles). The ring was unexpectedly bright, apparently due to forward scattering of sunlight by small ring particles. Voyager 1 discovered the ring four months ago.

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